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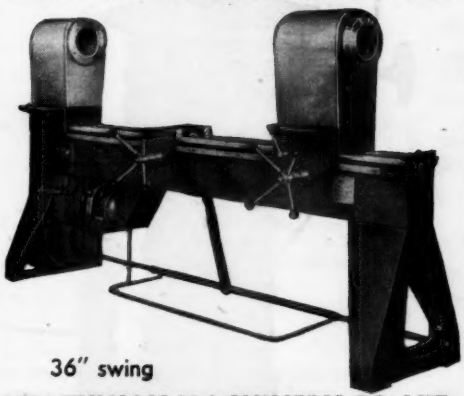

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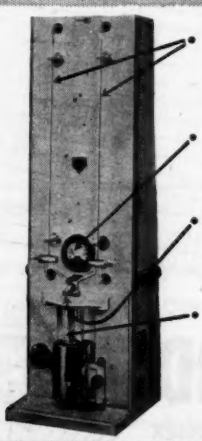

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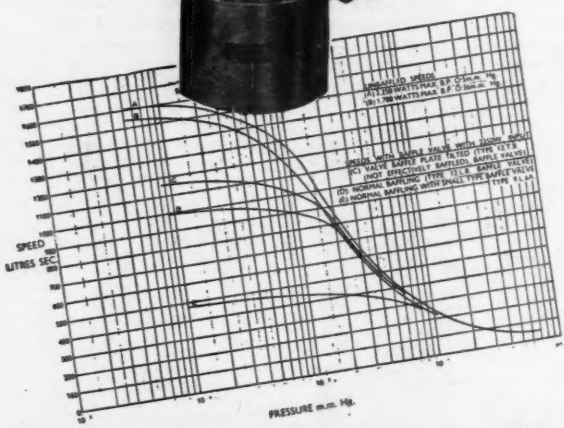

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NATURE

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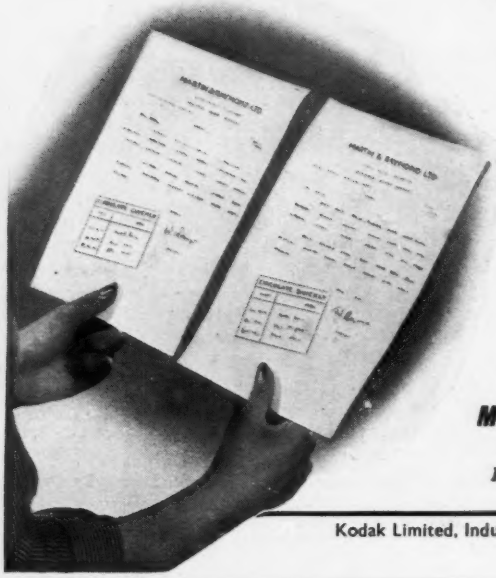

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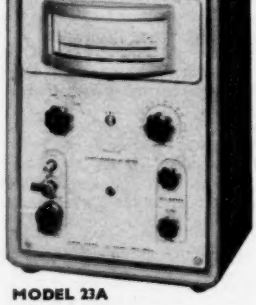

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MAN-POWER FOR COLONIAL DEVELOPMENT

THE Queen's speech at the opening of the new session of Parliament on November 30 indicated the Government's intention to prolong the Colonial Development and Welfare Acts and to increase the funds available under them, as well as its continued support of the Colombo Plan. The debate on the speech in the House of Commons on December 3 centred on Colonial development, and Mr. A. Lennox-Boyd, Secretary of State for the Colonies, said that he hoped to introduce a further Colonial Development and Welfare Bill at an early date which would provide additional sums for that purpose for 1955–60. He could not give any figures, as the Bill was not in final form; but there would be an overlap of a year between the money voted by the last Act and that which would be provided under the new Bill. The Colonies have already been asked to draw up their plans for 1955–60, indicating their priorities and the extent to which priorities can be met out of their own resources.

Mr. Lennox-Boyd pointed out that expenditure on Colonial development has been rising steadily and is now running at the rate of about £110 million a year. Excluding some major projects and the work of the statutory corporations and other public bodies, about £500 million is now involved in Colonial development, of which about half is coming from the local resources of the territories, about one-third from external loans, and one-sixth, or about £14 million a year, currently, from the Colonial Development and Welfare Fund. Some 43 per cent of the latter monies is spent on social services, 10 per cent on research, 5·6 per cent on surveys and censuses, nearly 20 per cent on economic purposes (mainly agriculture), and 15·5 per cent on communications.

Reviewing this expenditure, Mr. Lennox-Boyd particularized the expenditure of £14·5 million on public health and referred to the shortage of medical men and nurses in many parts of the world. Of the £23 million expended on education, between £7 and £8 million has gone on university education and about £4·8 million on technical and vocational training, and Mr. Lennox-Boyd welcomed the plea which Mr. James Griffiths had made for a greater development of technical education. The more we can do to encourage technical education, he said, the better we shall serve the interests of the Colonial territories by enabling them to live a full and complete life and meet on more even terms the problems of the modern world. He also welcomed the dramatic expansion in university facilities since the Second World War and, referring to the importance of the development of housing and water supplies, paid a warm tribute to an imaginative experiment initiated by Sir Edward Twining among the Mahoude in Tanganyika. He promised to look into a suggestion made by Mr. Griffiths in regard to the relationship between the Colonial Development Corporation and Colonial Development and Welfare Funds, and he also emphasized the importance of encouraging the development of craftsmanship.

Replying for the Government on this debate, the Under-Secretary of State for Commonwealth Relations, Mr. D. Dodds-Parker, dealt more particularly with the Colombo Plan, to which over six years Great Britain will be contributing about £300 million, of which £252 million represents the release of sterling balances. To India, Pakistan and Ceylon, these releases will amount to about £42 million a year, including £5 million for steel expansion in India and the same amount for the Sui Gas Transmission Company in Pakistan, while grants and loans to Malaya and North Borneo last year amounted to about £12·5 million. By June 1954 the United Kingdom had agreed to supply about £840,000 for equipment for research institutions, laboratories, and railway training, while under the Colombo Plan Technical Co-operation Plan alone it had found 621 training places by June 1954 and had offered the services of 155 experts, of whom 111 were accepted.

Mr. Dodds-Parker estimates that altogether Great Britain is spending about £200 million a year on overseas aid. This includes £1·33 million in support of the Specialized Agencies, £650,000 on the Technical Assistance Programme of the United Nations (to be increased to £800,000 this year), £18·5 million on Colonial development and welfare, £5·5 million on the Colonial Development Corporation, £23·5 million on Colonial loans as well as £10 million each to the Governments of Southern Rhodesia and New Zealand, £10 million to Pakistan in export credits and £400,000 for technical aid under the Colombo Plan. The Capital Issues Committee authorized private capital issues of £40 million while, through the World Bank, we released to India and Pakistan, in 1954, £10 million out of the £60 million for Commonwealth development spread over six years, and £42 million was released from sterling balances. The stress laid by Sir Arthur Braithwaite on the necessity for capital investment and the importance of providing adequate incentives was welcomed by Mr. Dodds-Parker. He said that the Government is doing its utmost to see that priorities are put in the right order. He stressed also the general shortage of qualified and experienced technical and scientific personnel, and both he and Mr. Lennox-Boyd emphasized the importance of the Colonial Territories themselves making the maximum use of their own resources in financing development. The Colonial governments have recently been informed of the Home Government's agreement in principle, and, subject to a review of the individual circumstances of each territory, to a small part of their currency funds, amounting to £365 million, held in London in the form of investments in United Kingdom issued securities, including some Colonial stock, being transferred into locally issued securities.

One point which was made by Sir Arthur Braithwaite and which, in slightly different form, was

stressed by Mr. Dodds-Parker, puts in its proper perspective the value of the welfare work among overseas students of the British Council. Sir Arthur, in connexion with civil engineering constructional work, stressed the value of bringing people from the Colonies to Great Britain for industrial, as well as academic, training. Mr. Dodds-Parker pointed out that many students come to Britain at their own expense. He was impressed, in his recent visit to Asia, with the number of people who wished to send their children to Britain for higher education, and he thought that this is a continuing contribution which Britain can make.

There are now more than 8,000 Colonial students in Britain, some 3,500 of whom arrived during 1953. Nearly half of them are West Africans; but practically every Colonial territory is represented. These figures alone emphasize the importance of the work of the British Council among overseas students, which, since 1949, has been met mainly from Colonial Development and Welfare Funds, with contributions from both the Foreign Office and the Commonwealth Relations Office also, since under the scheme initiated on January 1, 1950, the British Council is responsible for extending the welfare facilities for overseas students generally, as well as for maintaining hostels and other services for the welfare of Colonial students. Overseas students in the United Kingdom are now estimated to number about 25,000 compared with 10,000 in 1948, and although of the 3,647 students met by the British Council on arrival during 1953, 3,258 came from British Colonial territories and only 248 from foreign countries, accommodation of some kind at one time or another was found for 2,270 students from foreign countries during the year.

The latest report from the British Council*, which attributes the rapid increase in the number of overseas students to the increase in grants for study in British universities and technical colleges, and also to new schemes for training artisans in British industry and commerce arising directly out of Colonial development, reviews at some length the working of this scheme during the past four years, and the measure of its success in achieving its objectives. During that period, the Council's staff have met on arrival nearly 12,000 overseas students, more than 10,000 from Colonial territories, and confidence is expressed that the procedure devised for the purpose, in consultation with the Colonial Office and with the co-operation of the Customs and Immigration Authorities, has worked well and that a Colonial student is now helped through the inevitable formalities with sympathy and efficiency. It would, however, be of advantage if these reception arrangements could be expanded to meet the needs of other students from within and without the Commonwealth.

Most overseas students, on first arrival, go to London, where temporary lodging on arrival was found last year for some 6,500 students, nearly 5,500 from the Colonies. In 1953 a new hostel was opened in Lancaster Gate, London, primarily to meet this need, and it has now been recognized by the Colonial Office that such a transit hostel will be essential for some time to come. It soon became obvious that hostels for Colonial students were essential so long as the number continued to increase, with segregation in an undesirable type of boarding house as the only alternative. Accordingly, the policy of reducing the number of hostel beds envisaged in the 1948 discussions was abandoned: the Newcastle and Edinburgh hostels were reprieved and improved or extended, an enlarged and improved hostel for women students opened in London, while that at Lancaster Gate also provides some permanent beds.

Besides this hostel policy, which has also made Hans Crescent the centre for Colonial student activity in London, the Council has found permanent accommodation in private lodgings for more than 7,000 students, some 3,700 of them from the Colonies. Nearly 6,500 students have attended its vacation courses, for each set of which more than a thousand applications are received; and whereas in 1950 students from foreign countries attending these courses outnumbered Colonial students by more than four to one, in 1953, Colonial students were in excess by three to two. The value of these courses, like that of the various surveys and study visits, which are arranged by the Council but paid for mainly by the students themselves, lies in the fact that they enable students from different parts of the world to live for a time together and to get to know one another, and make it possible for them to see something of the practical sides of their subjects of study, to visit different parts of the United Kingdom and to meet a wide cross-section of the British public.

In London, and in the areas outside London where the Council has staff, there is either a centre for overseas students organized by the Council, or the Council is associated with an international club maintained for a similar purpose. Such centres provide a place where overseas students can meet each other and to which they can invite their British friends; and by enabling the Council's staff to get to know students individually, they also facilitate the arrangement of suitable hospitality for students in British homes. The activities of the centres are particularly useful in areas where there are large numbers of industrial trainees or non-university students.

London, however, presents problems which have never been satisfactorily solved; although some of the experiments in London boroughs have succeeded to an extent which has seriously overtaxed the small staff available. In 1953, the Council issued more than 9,500 invitations to overseas students to meet British people in their homes, or in societies or clubs, and some 1,700 students made new friends in this way. Other organizations are doing similar work; but the pressure on the British Council's Overseas Student Centre in London is such that the membership could be increased several times if premises and staff were available; it has therefore been necessary to limit membership to 1,200 students. On the whole, the report suggests that the recommendations of 1948 which set the scheme in motion are being fully implemented so far as Colonial students are concerned, although much remains to be done to meet

* Report of the Work of the British Council for the Year ended 31st March, 1954. Pp. v+105. (London: British Council, 1954). 2s. 6d.

the needs of students from the Middle East and South-East Asia.

There is, nevertheless, no room for complacency as to the work which the British Council is already doing among Colonial students, viewed simply as a complementary factor in Colonial development and welfare; or as to the desirability of increasing its scale and of supplementing it by private effort. If the comments in the debate on November 30 did not sufficiently bring out the bearing of such work on the effectiveness of programmes for technical assistance in the under-developed countries, the broadsheet which was issued almost simultaneously by Political and Economic Planning, "Students from the Colonies" (No. 374, November 29, 1954), although only a preliminary account of some of the difficulties which such students encounter in trying to understand the British and to adjust their ideas to life in Britain, gives a sober warning of how much remains to be done. The picture it reveals of frustration, nostalgia, disillusion and optimism, the evidence adduced of unhappiness, discontent and misdirection is disturbing; and not the less so because the tone of some students' criticism of their reception betrays a lack of drive and adaptability that speaks poorly for their ability to participate effectively in Colonial development.

Like the comments on this subject in the debate and the review in the British Council's report, this broadsheet indicates the need for some hard thinking matched by constructive action by all bodies concerned with the welfare of overseas students, by the university authorities and by the well-disposed public, whose private hospitality could probably do most to make these potential leaders of the under-developed and Colonial territories firm friends of Britain. That both Government spokesmen should have recognized something of this is to the good, and there should be no need to fear that adequate money will not be forthcoming for the purpose from Colonial Development and Welfare Funds. Government action can only go a certain way, and beyond this—quite apart from the indispensable influence which private bodies and individuals can exert—it would be helpful if there were less disposition to make Colonial development and welfare a matter of party politics.

WAR-TIME RADIOBIOLOGICAL RESEARCH

Biological Effects of External Radiation

Edited by Dr. Henry A. Blair. (National Nuclear Energy Series—Manhattan Project Technical Section. Division 6—Volume 2.) Pp. xvii+508. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 56*s*.

THIS volume, edited by H. A. Blair, is one of the sixty-odd of the National Nuclear Energy Series. The general preface states that these volumes will attempt to cover completely what has been 'declassified' of the results of research done in the many divisions of the Manhattan Project and the Atomic Energy Commission in the United States. This one presents the results of the major part of the work done during the war period at the University of Rochester on the biological effects of X-radiation and, in collaboration with the Biochemical Foundation of Newark, on the effects of fractionated neutron irradiations.

The major part of the material has been already published in scientific periodicals or was embodied in internal reports. While for the history of the subject there is no doubt that a record of these war-time researches will be useful, it is rather difficult to assess the immediate value of a volume which reports researches some ten or more years old, and which many of the authors have put into the present form when their interests were elsewhere.

The volume is divided into three parts. Part 1 deals with the effects of single doses of X-irradiation applied to the whole body. Part 2 deals with chronic exposure of the whole body, and Part 3 with the effects of fractionated doses of fast neutrons. Presumably, most of the work had as its object information both as to 'tolerance' doses for those exposed to radiation during their work, and as to the effects on individuals exposed to sudden single large doses as a consequence of acts of war. It follows that, with the exception of one of the papers—by Spencer and Stern on the relation between mutations and X-ray dose at very low levels—the content of the volume has not much general interest for the biologist, though it has for the radiologist.

The paper by Spencer and Stern is one of the first which attempted to establish the genetic effects of radiation at levels so low as merely to double the background. It is therefore one of the first papers to give experimental support to the extrapolation that in respect of their genetic effects there is no lower threshold for radiations, a matter which is even now taken lightheartedly by many.

Among the other papers the biologist not directly interested in radiobiology will find a number of interesting, though disconnected, facts. For example, the lethal mean dose of X-rays is about 200 r. for a guinea pig, about 300 r. for a dog, 500 r. for a rhesus monkey, more than 600 r. for a rat and a hamster, and about 800 r. for a rabbit. It would be most interesting to find what regularities there are in these species differences between mammals. Another interesting point, though well known, is the enormous difference in sensitivity of different tissues of one and the same animal—this not only in the severity of the injury but also in the speed at which it first appears, reaches its maximum, and may gradually vanish. For example, in the rat 550 r. produce histologically visible injury of the bone marrow fifteen minutes after irradiation, with complete recovery in forty days. In the testis the damage appears at six hours and recovery begins only after forty-two days.

Injuries to finger-ridge detail, both experimentally produced in monkeys, and detected in a sample of professional groups liable to irradiation (radiologists, orthopædists and dentists), reveal characteristic effects. 68 per cent of 1,033 radiologists, 55 per cent of 185 orthopædists and 40 per cent of 503 dentists showed detectable finger-ridge changes as compared with 1·8 per cent in a sample of 1,850 controls.

A number of other interesting findings of this kind are dispersed throughout the volume. For example, a chapter by R. D. Boche reports the effect of chronic X-irradiation on the length of life. There seems to be evidence that even as low a dose as 0·1 r. per day may shorten the expectation of life of rats. No

doubt by now experiments of this kind will have been repeated and vastly extended. It is essential for the peaceful development of atomic energy that knowledge of this kind should be made available without delay. G. Pontecorvo

APPLIED STATISTICS

Statistics for Technologists

By C. G. Paradine and B. H. P. Rivett. Pp. vii+288. (London: English Universities Press, Ltd., 1953.) 25*s*. net.

Statistical Methods in Electrical Engineering

By Dr. D. A. Bell. Pp. viii+175. (London: Chapman and Hall, Ltd., 1953.) 25*s*. net.

ANY book on statistical methods for a special group of readers is vulnerable from two directions—its development of the subject itself, and its suitability for the class of reader at which it is aimed.

"Statistics for Technologists" develops fairly logically those parts of the theory of statistics which its authors include. (Unfortunately, work-study teams wrestling with congestion problems will find no help here.) The approach could be improved, however, by more explanation of the general principles involved in significance testing. The authors are obliged, in their chapter on sampling inspection schemes, to mention briefly the two types of error involved in significance testing, and it would be helpful if some more detailed discussion of these underlying ideas could be inserted before the demonstration of particular tests.

It is perhaps a general criticism that although most engineers and scientific workers could comfortably digest the mathematics used, the basic statistical ideas, which are more difficult for the non-statistician to grasp, merit a little further explanation. Also, the way in which the examples are used to illustrate the text is not entirely satisfactory in a book specifically for technologists. Although many of these examples come from technological sources, on the whole they lack the circumstantial information which would illustrate to the student the sort of difficulties involved in practical application. It may be argued that applying theory requires only common sense, but common sense is greatly helped by the experience of others. With these reservations, this book is an adequate introduction to statistical methods for the mathematically minded reader, whether technologist or not.

In contrast, "Statistical Methods in Electrical Engineering" can scarcely be considered as in any way satisfactory in its present form. The result of narrowing the topics discussed to the field of electrical engineering has been to destroy continuity in the treatment of statistical methods. Only in the last two chapters, where the author deals with electrical fluctuations and information theory, does the book become at all convincing. The looseness of construction of the previous chapters can only result in confusing the reader who does "not wish to embark upon a statistician's course of study". For example, the author needs to use Bayes's theorem to derive the expression for the information content of a signal. He therefore discusses Bayes's theorem in his first chapter on probability, and states that it is controversial; but the quotations from Fisher and Jeffreys do not make it clear that it is the assumptions necessary to apply Bayes's theorem that cause disagreement, nor does he state what these assumptions are. Again, the use of the word parameter to describe the sample variance and "Student's *t*" will be irritating to the statistician and confusing to the non-statistician. It has perhaps even confused the author, for he makes the statement that "the random error of the answer deduced from the total of (N) observations is approximately $\sqrt{N}$ times less than if one relied on a single experiment (*actually* $\sqrt{N-1}$, which tends to $\sqrt{N}$ when N is large)". The omission of any discussion of congestion theory is even more noteworthy in this book than in the previous one, for the greater part of the theory was developed by Erlang and his successors specifically for electrical engineers concerned with telephone exchange problems, and an up-to-date definitive text has still to appear. Finally, it is surely superfluous in the appendix listing statistical tables to devote three separate sections to the different forms in which the normal integral is tabulated. F. Downton

AUTOMATIC DIGITAL CALCULATING MACHINES

Automatic Digital Calculators

By Dr. Andrew D. Booth and Dr. Kathleen H. V. Booth. Pp. vii+231+4 plates. (London: Butterworths Scientific Publications, 1953.) 32*s*. net.

AUTOMATIC digital calculating machines, though increasing in number and variety, are still not very numerous and are still news, rather sensational in the public mind. The idea that a calculation involving many digits can be performed in a matter of milliseconds is one that implants despair in certain temperaments, and breeds a curious brand of mechanical mysticism in others. The remedy for such reactions is to read a straightforward and objective book on the historical development and present status of such calculation; and for this purpose the book under notice seems admirable. The authors have the practical and theoretical qualifications, experience with different types of computing machine, enthusiasm for the subject, and a clear and unassuming style of exposition.

The historical introduction is brief, so far as it refers to dates earlier than 1940. The initiator is, of course, Charles Babbage, whose wilful face stares from the pages of any history of calculation, a man whose imagination was exact regarding the possibilities of machine calculation, but far ahead of the mechanical resources available in his own age; a man unable, however, partly through temperament, to retain the sympathy of the government of the time or the continuation of financial support. His ambitions foundered in 1842; so that it was almost a century before the coming of electronic techniques enabled those dreams to be more than realized. The third chapter of this book summarizes the rapid advances that took place between 1940 and 1950.

Several chapters of a descriptive kind follow, in which the technicalities of input, output, control and the various operations, addition and subtraction, multiplication, division and others of miscellaneous nature, are detailed in the clearest manner with excellent diagrams. Chapters on storage follow, and here unfortunately the word 'memory', with its misleading anthropomorphic associations, seems entrenched in the literature and hard now to dislodge.

Lastly, there are chapters on coding and coded routines, illustrated by square root, interpolation and the like, and that question of mechanical translation from one language to another which aroused newspaper controversy and misunderstanding not long ago.

Concluding sections deal with the "playing of games" by machines, and "machine learning and intelligence". Here the reviewer, having followed so far with interest and profit, found himself in mental opposition to such phrases as "conditioned reflex" of a machine, or its "awareness". But perhaps these pages of Erewhonian speculation are merely a fanciful epilogue. In any event, they do not detract from the value of a very good and compact book, rather costly for its 240 pages, but probably indispensable in the growing literature of texts dealing with electronic calculating machines.

A. C. AITKEN

ENZYMES, GENES, VIRUSES AND BACTERIA

Annual Review of Microbiology

Edited by Charles E. Clifton, in association with Sidney Raffel and Roger Y. Stanier. Volume 8, 1954. (Stanford, Calif.: Annual Reviews, Inc., 1954.) 7 dollars.

THE need for regular, critical surveys of recent work which are something more than lists of references with titles, but at the same time less detailed than articles in the standard review periodicals or "Advances" series, is uncontested. Indeed, publications in the "Annual Review" series have become an essential aid to biological research and are a partial answer to the appalling quantity of scientific literature which now faces the research worker.

The extent to which recent work can be subjected to reasoned criticism in these series is severely limited by lack of space. It is, however, variable and therefore apparently left in some degree to the discretion of contributors. It would be unfortunate if the opportunity for comment were subjected to any further restriction. Even at the risk of a more individual approach and the relegation of some papers to a bibliographical list printed as an appendix without comment, a review article should aim at critical assessment of at least some of the work done on a particular subject.

One example, in this volume, of what can be done is the comprehensive and extremely useful review on "Genetics in Micro-organisms" by S. Spiegelman and O. E. Landman. This is a real *tour de force*, with 481 references cited in fifty-six pages of condensed, almost telegraphic, English. It is readable, but exhausting.

In general, the articles are widely and fairly distributed among different fields: general microbiology, 5; bacteriology, 6; viruses, 5; immunology, 3; protozoology, 2; and mycology, 1. Selection for comment is always apt to be misleading, and must be taken largely as an indication of the reviewer's particular interests.

The most striking impression obtained is that of the remarkable and fascinating advances made in the study of bacteriophage and in bacterial genetics. Workers in other fields must envy the way those studying phage reproduction and genetics have broken through into the open during the past five years. This is clearly illustrated by a short and excellent review, by E. A. Evans on "Bacterial Viruses", which is easily assimilated, even by those unfamiliar with the subject.

The important recent advances made in the study of viruses grown in tissue cultures (with special reference to poliomyelitis virus grown on human or monkey cell homogenates) have been reviewed in a very helpful and thoughtfully written article by J. F. Enders.

Among other articles of special value and interest is one by A. H. Coons on "Labelled Antigens and Antibodies". Fluorescent, iodinated, coloured, chemically marked and isotopically labelled proteins are being used on an increasing scale in the study of antibody formation. C. L. Oakley has written a characteristic review on "Bacterial Toxins" where he describes in some detail the intricate, immunological analysis of culture filtrates containing several different, physiologically active proteins. He suggests the term 'soluble bacterial antigens' as a substitute for 'toxins'. One can sympathize with some of his feelings; but, if there is going to be a change, why not move straight towards a biochemical basis of nomenclature? It should at least stimulate more badly needed biochemical work on the characterization of these substances.

In microbial metabolism the importance of coenzyme A is becoming increasingly recognized, as emphasized by J. R. R. Campbell in an article which includes four pages on recent advances in the study of adaptive enzymes. W. W. Umbreit devotes fourteen pages to "Mechanisms of Antibacterial Action" in an article which is useful largely in indicating how extraordinarily little is known about these mechanisms. His implication that the mode of action of penicillin and streptomycin is now more or less understood is—in spite of some important work on streptomycin (particularly by himself and colleagues)—somewhat misleading.

In a review of "Changes in the Host Flora induced by Chemotherapeutic Agents", E. McCoy stresses the increasing proportion of bacterial strains found resistant to penicillin or streptomycin (especially in hospital infections, where it can be as high as 80 per cent) and, more recently, to chlor- and oxy-tetracycline and even to erythromycin. So far, instances of cross-resistance are not numerous; but the outlook is not encouraging.

There are two articles on bacterial cytology: a useful review by S. Mudd on the "bits and pieces" of bacteria (flagella, capsules, cell walls, mitochondria, microsomes, etc.); and a more difficult article by E. D. DeLamater on "The Bacterial Nucleus". It is unfortunate that a rather bitter controversy on the mechanism of nuclear division (and other matters) should have obscured some of the genuine advances made in this field.

It is difficult not to be impressed by the almost overwhelming advantages offered by work on micro-organisms in the pursuit of nearly every kind of biological problem. It would be understandable if impatient physiologists, biochemists, virologists and geneticists now working with plants or mammals were tempted to drop their present occupation and concentrate for ten years on analogous studies on a convenient, non-pathogenic species of bacterium in order to make some rapid discoveries which would almost certainly be immediately applicable to their original research problems.

M. R. POLLOCK

COLONIAL RESEARCH IN THE BRITISH COMMONWEALTH

THE first annual report of the Colonial Research Committee was published in May 1944 as a slender Command Paper of eleven pages. The second annual report was issued in August 1945, along with those of the Colonial Products Research Council and the Colonial Social Science Research Council, under the title "Colonial Research, 1944–45", a Command Paper of 31 pages. Now, "Colonial Research, 1953–54" is a substantial publication of 278 pages*. Besides the annual reports of the three original bodies, it contains the ninth annual reports of the Colonial Medical Research Committee and of the Committee for Colonial Agricultural, Animal Health and Forestry Research, the seventh annual reports of the Colonial Insecticides, Fungicides and Herbicides Committee and of the Colonial Economic Research Committee, the Colonial Fisheries Advisory Committee's annual report on fisheries research for 1953–54, and the reports for 1953–54 of the Tsetse Fly and Trypanosomiasis Committee and of the Director of the Anti-Locust Research Centre, as well as reports on miscellaneous matters not covered by the reports of the specialist advisory bodies.

All these reports include lists of reports and other publications issued during the year; but neither in the brief report of the Colonial Research Council nor elsewhere is there, however, any attempt at a considered conspectus of the work of these ten specialist bodies and its bearing on Colonial development and welfare work generally and in relation to British resources and research activities as a whole. The nearest approach to such a survey is provided by the list of research schemes approved under the Colonial Development and Welfare Acts in 1953–54 and in the comments of the Colonial Research Council on those schemes. There may well be some administrative convenience in publishing these annual reports *en bloc*; but the title is something of a misnomer unless it is accompanied by some general survey or summary directing attention to the most important implications for Britain's commitments in research, for Colonial development and welfare and for technical assistance to the under-developed areas. Such a survey is now well overdue and in its absence less than justice is being done to the British effort.

The forty-two new schemes and forty-nine supplementary schemes made during the year, involving grants totalling £728,510, brought the net expenditure and commitment from Colonial Development and Welfare Funds since 1940 to about £12 million at March 31, 1954. Of the gross allocation of £13 million, about 33 per cent has been for agricultural, animal health and forestry schemes, 15 per cent for medical research, 12 per cent for fisheries research, 10 per cent for tsetse fly and trypanosomiasis research, 9 per cent for social science and economic research, 8 per cent for insecticides research, 5 per cent for research sponsored by the Colonial Products Research Council, 3·3 per cent for anti-locust research and 4·6 per cent for miscellaneous schemes, including building and road research. About 40 per cent has been for schemes to benefit the East African territories, 19 per cent for the West African group, 10 per cent for the South-East Asian territories and Hong Kong, 8·4 per cent for the West Indian Colonies, British Guiana and British Honduras, and 5·6 per cent for the Central African territories.

Of the major schemes approved during the year, the largest are £123,743 for the establishment of the West African Council for Medical Research; £110,000 for continuation of research at the East African Veterinary Research Organization; £66,984 for the maintenance of the West Indian Institute of Social and Economic Research; £44,809 for control of malaria in the hyper-endemic area of Taveta-Parc, East Africa; £31,330 for the continuation of sugar technology research at the Imperial College of Tropical Agriculture, Trinidad; £20,492 for research in Jamaica into the 'unknown' disease of coconuts and Panama disease of bananas; £18,750 for the preparation at the Royal Botanic Gardens, Kew, of the "Flora of Tropical East Africa"; £16,000 for the establishment of the malarial unit in East Africa; £16,022 for investigation into the control of filariasis in Fiji by insecticidal methods; £14,915 for research in Malaya on virus and other diseases transmissible from animals to men; £14,780 for the establishment of a Fungicide Research Unit in West Africa; £14,300 for banana-breeding research in Jamaica; £13,525 for the establishment of a pool of Colonial soil surveyors; £12,290 for the expansion of the Veterinary Research Laboratory, Vom, Nigeria; and £12,250 for the maintenance of the West African Institute for Trypanosomiasis Research.

The eleventh annual report of the Colonial Products Council, which on January 1, 1954, replaced the Colonial Products Research Council and has assumed responsibility for the general supervision of the Colonial Products Laboratory (formerly the Colonial Products Advisory Bureau), notes that eighty investigations were carried out in the Laboratory and 786 inquiries handled. Investigations on West African groundnuts continued, with particular reference to the effect of insect attack on quality. An improved technique for assessing insect infestation in maize was devised for use in Colonial territories, and African methods of preparing gari from cassava are being studied with the view of mechanizing the process. Good progress is reported in building up a reference collection of photomicrographs of fibres obtained from botanically authenticated plants. Some experimental work was carried out on the chemical retting of cotton stalk fibre and *Hibiscus cannabinus* with the view of determining which of the commoner and cheaper chemicals could be used. Pulped by the sulphate process, batai wood (*Albizzia falcata*) from the Federation of Malaya gave a pulp comparing very favourably with coniferous sulphate pulps, and a mixed sulphate cook of three species of timber from Kenya gave a bleached pulp suitable for incorporation in printing or writing papers. Good-quality pulp suitable for high-strength

* Colonial Office. Colonial Research 1953–54. Reports of the Colonial Research Council; Colonial Products Council; Colonial Social Science Research Council; Colonial Medical Research Committee; Committee for Colonial Agricultural, Animal Health and Forestry Research; Colonial Insecticides Committee; Colonial Economic Research Committee; Tsetse Fly and Trypanosomiasis Research Committee; Colonial Fisheries Advisory Committee; Director—Anti-Locust Research Centre; and Research Matters not covered by the above Reports of the Specialist Advisory Bodies. (Cmd. 9303.) Pp. 278. (London: H.M. Stationery Office, 1954.) 7s. 6d. net.

papers was obtained from ribbons of *Hibiscus cannabinus*, obtained in work in Nigeria on the mechanized production of stem fibres.

Work on the chromatographic separation of the active principles of pyrethrum flowers has led to a method for the separation and spectrophotometric determination of the pyrethrin I and pyrethrin II fractions. A comprehensive investigation of the assay of the proteolytic enzyme pepsin (the dried latex from the fruit of the paw-paw tree, *Carica papaya* L.) was commenced. Further work on Colonial sources of essential oils rich in safrole has indicated that distillation of the wood and bark together of 'medang kerangas' should give an oil containing more than 80 per cent of safrole. Extensive work on eugenol and its derivatives has indicated that eugenol dibromide is of interest for the preparation of soluble vicinal dithiols for preventing poisoning by heavy metals, and that 1-(3′ : 4′-dimethoxybenzyl)-5-propyl-7 : 8-dimethoxy*iso*quinoline hydrochloride has an interesting biphasic effect on blood pressure. Work on groundnuts continued; but trade trials of sugar-cane wax in pastes, cream polishes and emulsions have been disappointing, and little progress has been made in finding a market for the wax. Attempts are being made to determine the constituents of mangrove bark responsible for the objectionable dark colour of the extract. Work on carbohydrates included the isolation of a range of dextrans by growing bacteria and moulds on cane sugar; the isolation from cultures of *Betacoccus arabinosaceous* of the dextran-synthesizing enzyme dextransucrase in complex formation with dextran; study of the glucamylase of *Aspergillus niger*; the synthesis of fluorine derivatives of sugars and sugar alcohols and the production of cellulose from industrial wastes.

The performance of the experimental sugar factory at Trinidad in 1953 compared well with its performance in 1952, and modernization is now almost complete. Considerable advance has been made in clarification studies, and a system has been devised for cleaning sugar factory evaporators when coated with the most intractable of scales. Conditions have been established for converting molasses into lævulinic acid and isolating the product. A more extended study of the fermentation of cocoa beans is being undertaken, and methods have been developed for the determination of each polyphenolic component of fresh and cured cocoa beans. Besides the microbiology of jute, the nature of the pectic substances of the plant has been explored.

The tenth annual report of the Colonial Social Science Research Council records as the principal difficulty the recruitment of senior staff. Of the five American social scientists appointed under the special scheme for training American social scientists at British universities, Mr. E. H. Winter has joined the staff of the East African Institute of Social Research and Mr. and Mrs. A. Harris are returning to work in association with that Institute under the project for the study of African leadership, for which the Carnegie Corporation of New York has given £30,000. A Social Research Unit of three research Fellows was set up in the University of Malaya; but no successor had been found to Prof. W. Hamilton Whyte as director of the West African Institute of Social and Economic Research. A linguistic survey of the British Caribbean Colonies is being undertaken by the University College of the West Indies, while at the University of Hong Kong the research programme has been very much extended. Studies under Prof. E. H. G. Dobby at the University of Malaya have covered land-use and tenure in Langkivi, the conservation of resources in Selangor and the human ecology of the fishing villages near Kuching, Sarawak. Among studies undertaken by Colonial administrative and specialist officers during the year, special reference is made to Dr. W. L. I. Verrier's research into the demography of Fijians, the research by the Rhodes–Livingstone Museum into prehistoric archæology in Northern Rhodesia and the adjacent territories and into the material culture of Northern Rhodesian tribes, particularly the Hukwe Bushmen and the tribes of Southern Barotseland, and the anthropological research by the Sarawak Museum on the Kelabits of the far interior, on group contacts and conflicts, and on native legend with particular reference to migrations and geography.

Nine further sections of the Ethnographic Survey of Africa were published during the year, making a total of twenty-four volumes. Of the "Handbook of African Languages", Part 3 of the General Survey, "Non-Bantu Languages of North-East Africa", was in the press, and a special study, "Bantu Languages of Western Equatorial Africa", by M. Guthrie, was published during 1953. A number of other projects have been completed for publication, and lists of these items and of publications during the year by workers assisted from Colonial Development and Welfare Funds are appended to the Council's report, together with the annual reports for 1953–54 of the Directors of the East African Institute of Social Research, the West African Institute of Social and Economic Research, the Institute of Social and Economic Research, the University College of the West Indies, and the Rhodes–Livingstone Institute, and the report for 1953 of the Educational Research Institute for Fiji and Western Pacific Territories.

To the nineteen established research schemes under the scientific supervision of the Colonial Medical Research Committee at the beginning of the year, two major long-term schemes have been added: a field study of schistosomiasis in the Gambia, and a three-year study of the effects of changing temperature on insect physiology and behaviour, with special reference to insect relations to climatic conditions in the tropics. The Committee's ninth annual report records the filling of five further vacancies and the posting of three research students—one overseas and two in London. In February 1954, under a financial scheme made by the Committee, a five-day conference on virus diseases was convened in Kuala Lumpur, with Prof. P. A. Buxton as chairman. The conference included, besides British and American workers from the Institute there, investigators from South Africa, East Africa, the Sudan, Australia, the American Army and its Graduate and Research School at Washington, the Rockefeller Virus Research Unit at Poona, the Malayan Medical Service, the University of Malaya, the Armed Forces in Malaya and the Colonial Office. The meeting was concerned primarily with assessing the potential hazard of yellow fever; but discussions ranged over the wider field of arthropod-borne virus diseases, and comprehensive recommendations were made for relevant investigations. The Committee has also convened a conference of experts available in the United Kingdom, under Brigadier J. S. K. Boyd as chairman, to review the present scientific position of the sickle-cell trait and sickle-cell anæmia

and to advise it on suitable lines of investigation. The Helminthiasis Sub-committee, having considered, in connexion with schistosomiasis, the pressing need for clarifying the present confusion in the identification of African snails carrying schistosomes and for correcting the over-emphasis hitherto placed on conchological evidence only, has directed attention to the desirability of having men trained in malacology, and of instituting a centre at which continuity of malacological studies could be maintained. To meet these needs, it recommended that a Government research fellowship should be made available at the British Museum (Natural History) for research on snails in relation to schistosomiasis and other fluke infections of man and his domestic stock and their control. Ten members of the Committee and Sub-committees visited various units in the field, and facilities of the research units continued to be much used by research workers from the United Kingdom for the short-term study of specific problems.

The East African Standing Advisory Committee for Medical Research has recommended the establishment of a special unit to carry out demographic studies and to compile the vital statistics so essential as a background for many problems in medical research. The East African Government has approved the proposal to set up a council for Medical Research in East Africa as a corporate body. The Helminthiasis Research Unit at Kumba, British Cameroons, concentrated its work on loiasis and its transmission by *Chrysops* on obtaining as complete a picture as possible of the life-cycle of the principal vector, *C. silacea*, and a comprehensive knowledge of its habits, food requirements and movements; and on ascertaining the identity of the species of filarial worms found in the monkey population of the forest canopy and whether the filariæ in the monkeys are the same species as those occurring in man, and also whether they develop in the same species of *Chrysops*. It has been established that the migrating filariæ of *L. loa* develop not only in *C. silacea* and *C. dimidiata* but also in *C. langi* and *C. zahrai*, and an almost continuous census has been maintained of the infection-rate in the human and fly populations both at Kumba, where monkeys are common, and at Sapele, where they are absent. Lack of staff restricted the mapping of the incidence of bancroftiasis in Tanganyika and in part of Kenya, but it is estimated that in Tanganyika two million people harbour the parasite. Random sampling of populations in Kenya indicates that onchocerciasis is extremely common in the high hills cupping the north-east portion of Lake Victoria.

Under the filariasis research scheme commenced in Malaya in July 1953, the main work is to be done in heavily infected hamlets along the lower reaches of the Pahang River in East Pahang, with headquarters at Kuantan. A pilot mass-treatment campaign indicated that the main difficulties inherent in any attempt to control Malayan filariasis by treatment with 'Hetrazan' or 'Banocide' are erratic attendance at the drug-parade, the occurrence of febrile reactions in about one-fifth of the persons whose bloods contained no microfilariæ, and the development in many persons of symptoms of intolerance to doses of the drug which had been borne quite well by patients in hospital.

Investigations on guinea-worm at University College, Ibadan, were aimed at providing specially designed wells in selected rural areas in the heavily infested zones as a practical prophylactic measure, and laboratory studies on the early stages of development of the guinea-worm in the mammalian host, using puppies as the experimental animals. The East African Malaria Unit at Amani has been expanded, making possible a more rounded attack on malaria problems; and the total *Anopheles* population in a particular district has been estimated by a system of mass spray-catching in houses. In studies on the existence of biological races in *A. gambiae*, the maxillary index in wild-caught specimens and in females bred from two different strains of this species maintained as laboratory colonies was investigated. Sprayings with residual insecticides on a sugar estate in Northern Tanganyika indicated that the average dosage of 1·5 gm. per sq. m. of 'Gammexane' dispersible powder is required to maintain a low anopheline house population, but such a treatment had no apparent effect on the parasite-rate of the adult estate population. In Nigeria the Ilaro Experimental Control Scheme was concluded and an assessment of long-term suppression of malaria in three hundred African school children is in its second year. Studies of the newer anti-malarial drugs continued at the Institute for Medical Research, Kuala Lumpur, and the effect of residual insecticides on Malayan mosquitoes was also examined.

At the West African Virus Research Institute, Lagos, an *in vitro* test for detecting yellow fever antibodies is being developed, and the East African Virus Research Institute, Entebbe, investigated an epidemic of dengue-like fever in Newala District, Southern Tanganyika, and has shown that *A. aegypti* was the main vector. Work continued on virus–tissue relationships, on the virus of Rift Valley fever, and on the hatching impulse in eggs of mosquitoes of the genus *Aëdes*. Epidemiological investigations at the Trinidad Regional Virus Laboratory indicate the presence in certain areas of Trinidad of a virus agent closely related to, or identical with, Ilheus virus, which is immunizing a considerable proportion of the population.

In a summary of observations made by the United States Army Medical Research Unit in Malaya, reference is made to a long-term study of the incidence and manifestations of arthropod-borne viral infections of humans in Malaya and their ecology; to an exploratory survey which indicates that leptospirosis is very prevalent in man, domestic animals and wild rodents in Malaya and emphasizes the importance of the primary jungle as an endemic focus; and to field studies in North Borneo which indicate that 'Dieldrin' and 'Aldrin' provide an effective and practical means for controlling the mite vectors of scrub-typhus through the disinfestation of terrain.

Investigations on relapsing fever in East Africa are now being concentrated on the south-western regions, where the disease is much more prevalent. At the Lister Institute of Preventive Medicine, London, the inhibition test for the identification of blood-meals of closely related species has been established as a routine measure. Work on acclimatization in insects at the London School of Hygiene and Tropical Medicine has confirmed that the chill coma temperature and the ability to survive cold can be substantially modified by keeping several insects for twenty-four hours or less in warmer or cooler conditions within their normal zone of activity, and has also shown that tolerance to temperatures at the upper limits can be altered. Academic studies at the Hot Climate Physiological Research Unit, Nigeria,

were mainly concerned with nutrition; but the Unit has also made observations of working conditions in the Enugu Colliery and physiological observations on a training march of the Fourth Battalion of the Nigeria Regiment which are of value to civilian as well as to Service authorities. Evidence has been obtained which suggests that the sickle-cell trait affords much protection against subtertian malaria; in Nigeria, where 'Dapsone', as elsewhere, is now the routine treatment for leprosy, a three-year study of thiosemicarbazone has given evidence that resistance to the drug develops. Investigations of goitre in Sierra Leone suggest that the chief factor in the distribution of endemic goitre there is the difference in iodine content of the rocks from which the drinking waters and local foodstuffs are obtained.

The East African Medical Survey completed its first phase of five years in December 1953, and its investigations, which have comprised field-surveys to establish pictures of disease in East Africa, laboratory research on methods of control of disease, and pilot schemes to assess the efficiency of these methods, are summarized in the report. There is also a brief summary of work undertaken in the Federation of Malaya on nutrition, of work in Jamaica on vomiting sickness and the psittacosis–lymphagranuloma venereum group, and in Kenya on kala-azar, on the primary reservoir of plague, and the eradication of *Simulium neavei* from onchocerciasis foci by treating the rivers with DDT emulsin.

Grants totalling £235,043 for new and supplementary schemes were made during the year from Colonial Development and Welfare Funds by the Committee for Colonial Agricultural, Animal Health and Forestry Research, the annual report of which again acknowledges particularly the assistance of the Commonwealth Institutes of Entomology and of Biological Control and the Commonwealth Mycological Institute. In East Africa, where all sections of the Agriculture and Forestry Research Organization report progress, glasshouse studies have shown that resistance to *Puccinia polysora* may exist in certain Central American maizes, whereas none has been found in any African type; and that resistance appears to be controlled by a dominant major gene. Evidence has been obtained that in the Aberdare Mountains cypress plantations intercept less water than the natural bamboo cover, and are therefore preferable in conserving underground water supplies. At the East African Veterinary Research Organization, rinderpest research has led to the development of a conglutination test for rinderpest, and field-surveys have shown no evidence that immunity to East Coast fever is produced by recurring clinical disease, although it is probably constantly reinforced by infected ticks. Valuable information has been obtained on the timing of anthelmintic treatment by studies on the development of *Haemonchus* larvæ under field conditions. The joint Animal Industry Division, shared by the two research organizations, has made a promising start, while the four West African Governments have agreed to establish a Permanent Standing Advisory Committee for Agricultural Research.

The West African Cacao Research Institute has opened a sub-station at Moor Plantation, Ibadan, for the study of the somewhat different problems encountered in Nigeria from those of the Gold Coast. Cacao virus studies have revealed five new hosts of swollen shoot virus, and special studies are being made on *Cola* spp. in collaboration with Kew Herbarium, and a chemical method has been developed for the diagnosis of swollen shoot virus in leaves of symptomless trees. The fitting-up of the laboratories of the West African Rice Research Station, Rokupr, Sierra Leone, was completed, and besides research on rice selection and breeding, trials were commenced on the use of hormone arboricides for the destruction of mangroves on land.

At the West African Institute for Oil Palm Research, work was concentrated on agronomy, plant breeding and plant pathology, and is supported by a strong Statistics Division. The breeding programme of the West African Maize Rust Research Unit is now sufficiently advanced for some rust-resistant selections to be grown in multiplication plots for distribution to farmers, and increasing attention is being given to breeding varieties resistant to other diseases and pests, particularly stem borers. Hybridization of the Gros Michel banana with synthetic parents continued at the Banana Breeding Station in Jamaica, the Anglo-Columbian expedition in search of new material for cacao proceeded into 1953, and work continued on shade and nutrient relations, hormone sprays and nutrient injections, iron chlorosis, stock-scion relationships and systems of training young cacao. A detailed ecological survey of cacao estates in Trinidad was commenced.

Among the research undertaken by Colonial Departments and which is recorded in this report may be mentioned the chromatographic investigation, in British Guiana, of the amino-acid distribution in sugar-canes for different 'leaf-scald' reaction; the success obtained in the Gold Coast in control of the common borers attacking maize, *Sesamia* spp. and *Busseola fusca*, by dusting the young plants with DDT fourteen and sixteen days after germination, and the good results obtained by the pasture research section in Kenya in widespread trials with a strain of *Setaria sphacelata* ex Nandi. Promising results in yield, strength of straw, and earliness have been obtained in widespread trials of local varieties of rice in Malaya. In tea research, copper sprays continued to give the best control of blister blight (*Exobasidium vexans*), though copper dusts have also recently given good control. Trials in the destruction of forest weeds in Malaya continued, and in further tests against ambrosia beetles creosote gave good protection to barked logs when applied by brush. The Veterinary Research Institute was opened on June 10, 1953, and its work has so far been directed mainly to the production of vaccines for immediate field-use and to the diagnosis and confirmation of live-stock disease from specimens submitted by field-officers. In Nigeria a new study of the effect of green manure on land depleted of organic matter was started, while the Forest Research Branch, Ibadan, continued to investigate the regeneration of the high forest, particularly with the view of decreasing costs of regeneration. At Zanzibar the premature nut-fall and gummosis of coconuts caused by the Coreid bug *Theraptus* and other insects were further investigated, and preliminary spraying trials indicated that 'Dieldrex' is the most effective insecticide for the control of the more serious *Anophelepsis custodiens*.

The seventh annual report of the Colonial Insecticides, Fungicides and Herbicides Committee includes, as usual, an account of the work of the Colonial Insecticide Research Unit at Porton, where in studies

on the behaviour of urea-formaldehyde resins containing insecticides it was found that non-blooming films containing low concentrations of 'Dieldrin' possessed a high residual toxicity to some insects. Particularly promising results were obtained in laboratory tests of granular insecticides as larvicides, and the engineer attached to the team succeeded in fitting a rotary brush-spray unit to an Anson XIX aircraft and testing its operation, as well as fitting a hopper for pelleted material to a D.H. Beaver aeroplane. At the Imperial College Field Station work continued on the penetration of the insect integument by DDT solution, the contamination of flies by particulate deposits and the olfactory stimulation of tsetse flies. At Long Ashton Research Station trials continued on the adhesion of copper fungicidal spray deposits to foliage with and without stickers, while the work at Rothamsted was again concerned with the loss in toxicity of DDT deposits on foliage and on glass plates under simulated tropical conditions, and the prevention of such loss. The Research Unit at Arusha continued to work on the same lines as last year, and a reduction of tsetse fly of more than 99·96 per cent was achieved by large-scale aerial spraying with DDT at Maruzi, Uganda. Other work was concerned with the defoliation of bush and control of weeds, of mosquitoes and of grain-eating birds. Good progress was made in establishing the research unit at Ilonga, Tanganyika. The investigation of the ecology and habits of *Anopheles gambiae* in Mauritius, filariasis research in Malaya and research on defoliants in East Africa continued: the latter investigations indicate that aircraft application of *n*-butyl 2 : 4 : 5-trichlorophenoxyacetate will defoliate a wide range of species of trees.

Other work noted in the report is that in Malaya on the trials with 'Dieldrin' against *Anopheles maculatus*, *A. sundaicus* and *Culex fatigans*, and on the destruction of forest weeds, that with 'Dieldrin' in Tanganyika for control of white coffee borer, *Anthores leuconotus*, and that of the Mosquito Control Service in British Guiana on the bionomics and control of *Culex fatigans* and the comparative toxicity to its larvæ of DDT, BHC, 'Chlordane', 'Dieldrin', 'Aldrin' and other insecticides.

The Colonial Economic Research Committee still finds difficulty in attracting native scholars to work in the Colonial Territories, but has been able to secure excellent candidates for its new projects. Dr. F. C. Wright completed his study of the structure and organization of the distribution industry in Tanganyika and Nyasaland. Dr. Ida Greaves was preparing a report on the methodology of capital formation studies with special reference to Jamaica, Mr. D. T. Edwards was making a detailed study of the economics of small farms in Jamaica, and Mr. A. D. Knox was completing a study of the development of trade between British West Indian territories, past and present. Mr. F. H. H. King was studying the monetary systems of the Far East. At the beginning of the academic year 1952–53, a research division was established, with Colonial Development and Welfare and Gold Coast Government funds, within the Department of Economics of the University College of the Gold Coast.

The report for 1953–54 of the Tsetse Fly and Trypanosomiasis Committee reports good progress in the construction of the Central Trypanosomiasis Research Laboratory at Sukulu for the East African Tsetse Fly and Trypanosomiasis Research and Reclamation Organization; but the shortage of qualified officers continued until late in 1953. Studies of *G. morsitans* continued throughout the year, and research on *G. pallidipes* has been undertaken in the Lambwe Valley (Kenya) and in the Busoga district of Uganda. Field-trials of the role of biting flies have shown that 37·5 per cent of a small herd of cattle contracted *T. congolense* infections over a period of ten months in 1953, and 17·0 per cent of another herd after exposure for six weeks. In field-experiments, regular administration of 'Antrycide' at two-monthly intervals for a limited period daily protected cattle against *G. austeni* even after the cessation of treatment. Experimental reclamation and pilot schemes in the three East African territories proceeded according to the general plans. The West African Institute for Trypanosomiasis Research reports that *T. vivax* is not only the species of trypanosome most commonly found in zebu cattle in Northern Nigeria, and probably elsewhere in West Africa, but also that in some localities this species is capable of causing a high proportion of deaths of the host. Factors governing its transmission by *G. palpalis* have been further studied, and studies on the tolerance of Ndama cattle to trypanosomiasis continued. Further experience indicates that 'Antrycide' methyl sulphate gives uniformly satisfactory results in treatment of zebu cattle infected with trypanosomiasis in West Africa, and recent experiments have shown that 'Antrycide'-resistant strains of *T. congolense* became progressively less resistant after serial passage.

Work on the use of 'Melarsen' in the treatment of human trypanosomiasis continued in collaboration with the Nigerian Sleeping Sickness Service, and prophylactic 'Pentamidine' has proved an efficient, safe and rapid means of reducing the incidence of sleeping sickness in a population of 2,500 in a selected area in Northern Nigeria.

The annual report on fisheries research for 1953–54 of the Colonial Fisheries Advisory Committee reports vacancies for five scientific officers at existing research stations and an uncommitted balance on March 31, 1954, of £116,000, against which provision for new schemes and the extension of existing schemes to March 31, 1956, is estimated to total £80,700. The Inter-territorial Fisheries Research Station at Jinja, Lake Victoria, collected a comprehensive series of hydrological data, giving a better understanding of the complicated water movements in this Lake, and these movements have been related to the variable growth of plankton in certain areas. Observations on the rate of growth of *Tilapia* indicate that the quality of the food may be more important than the amount eaten. A thorough investigation has been made of the physical and chemical conditions obtaining in papyrus and water-lily swamps. At Zanzibar a comprehensive report has been written on the pelagic fishes, the taxonomy and distribution, the gear used in trolling and the various types of lures employed; but the joint Northern Rhodesia–Nyasaland Freshwater Research Station, which has now moved to Nkata Bay, Lake Nyasa, for a two-year investigation of the Lake, was able to carry out very little research on Lake Bangweulu owing to building delays. The West African Fisheries Research Institute's studies of the movements, growth, breeding and feeding habits of twenty-seven species of endemic marine and brackish water fishes have

shown that catches of *Drepane* species are affected by the phases of the moon.

The Fisheries Research Unit at the University of Hong Kong is now well established.

The report of the Director of the Anti-Locust Research Centre on locust research and control during 1953–54 emphasizes the need for additional accommodation. The present quarters are inadequate for the personnel, and while requests from abroad for the accommodation of research workers and students have to be refused, the recording and summarizing of current information on the developing plague of the desert locust continues to delay the progress of the research work essential for long-range planning of international anti-locust measures. During the year, 1,363 reports on the locust situation were received from thirty-eight countries and territories and the desert locust situation continued to deteriorate. The plague has extended almost to the maximum area liable to invasion, the intensity of infestation is likely to increase and exceptional efforts were required from the Desert Locust Control to reduce the dangers of devastation of East Africa, which was seriously invaded. Inadequate support by countries to the Food and Agriculture Organization's initiative for locust control in the Arabian peninsula led to large escapes from Arabia and elsewhere, which were responsible for the alarming increase in the infestations over the whole of the northern half of Africa and south-western Asia as far as India. Nevertheless, the research activities of the Desert Locust Survey are continually expanding and bearing fruit, and the International Council for the Control of the African Migratory Locust has also created a permanent research service.

Some miscellaneous matters not covered by the reports of the specialist advisory bodies are this year relegated from the report of the Colonial Research Council to a special section at the end of the report. These include the research of the African Studies Branch of the Colonial Office into problems of African administration such as land tenure and land policy; that under the Colonial Liaison Organization of the Building Research Station into the durability of paint, solar water-heating and climatological studies; and that of the East African Industrial Research Board and of the Colonial Road Research Advisory Committee, which refers particularly to problems of road construction in Malaya, Singapore, Sarawak, Brunei and North Borneo. Recruitment of field-staff for geodetic and topographic surveys kept just ahead of transfers and resignations; very satisfactory progress was made with geodetic surveys, the survey of control for mapping required for the Volta River project was completed and the output of mapping increased owing largely to fewer changes of priority.

The overseas scientific staff of the Colonial Geological Surveys increased from 190 to 197 during 1953, but twenty posts were still vacant. Satisfactory progress continued in all branches, including geological mapping, the investigation of mineral resources and the geological aspects of engineering and water-supply projects. The shortage of qualified meteorologists continued to restrict research work; but the East African Meteorological Department is studying problems connected with the artificial control of rainfall. In Mauritius, research on the correlation between rainfall deficits and excesses at the various seasons and the tonnage and sucrose content of the sugar-cane crop is expected to provide a more accurate guide to the tonnage of cane to be crushed and the probable total sugar production each year.

At the National Institute of Oceanography, the study of oceanic water movements is intended to have first place in the programme of research in marine physics, but progress is slow. Researches in marine physics are being linked as closely as possible with the biological work.

MECHANISM OF INTESTINAL ABSORPTION OF FAT

By Prof. A. C. FRAZER

Department of Pharmacology, University of Birmingham

FIRM progress in biological research is dependent on the proper use of hypothesis. From time to time a generally accepted view in some field of study may be shown to be wrongly based, and in this case a new hypothesis is needed to replace the old. But, in the change over from old to new, misunderstanding and confusion may arise. Such has been the case in the field of fat absorption. A statement of the main facts may help to correct this situation.

The story begins with the lipolytic hypothesis of Pflüger[1], which was put forward at the turn of the century and generally accepted as the basis for the fat absorption mechanism. The essential features of this hypothesis were the necessity for complete hydrolysis of glycerides, absorption of lipids from the intestinal lumen in water-soluble form only, reformation of glycerides in the intestinal cell and passage of particulate glycerides in the chyle, giving rise to the alimentary hyperlipæmia in the systemic blood. In 1936, Verzár and his colleagues[2] introduced some new facts which entailed the modification of the details of Pflüger's hypothesis. Thus, the bringing of the fatty acids into solution in water was considered to be largely due to the hydrotropic action of bile salts, rather than soap formation, as originally proposed. They also put forward the view that the re-synthesis of triglycerides in the intestinal cell had to pass through an intermediary phospholipid stage, which was controlled by the adrenal cortex. These modifications, however, did not affect the essential basis of Pflüger's hypothesis. Bloor[3] supported this view of the fat absorption mechanism.

Some doubts on the question of the completeness of lipolysis, especially in the cat, were expressed by Mellanby[4]. Stimulated by these observations, my colleagues and I carried out a series of experimental studies from 1934 onwards on various aspects of fat absorption. Our studies were especially concerned with particulate fat in the blood, the different effects and characteristics of absorption of various fatty acids and glycerides, lipolysis both *in vitro* and *in vivo* and defective fat absorption in human subjects[5–9]. This work led us to the conclusion that lipolysis need not be complete before the absorption

of glycerides occurred. Since no hydrotropic mechanism for glycerides could be demonstrated in the intestinal lumen, this conclusion was incompatible with two of the principal tenets of the lipolytic hypothesis. The methods we used were, of necessity, indirect, so that final settlement of this matter had to await studies involving the use of isotope-labelled molecules. These studies were eventually carried out by Favarger and his colleagues[10,11], Karnovsky and Gidez[12] and Reiser and his co-workers[13], all of whom substantiated our view that complete lipolysis was not an obligatory step in fat absorption. Our observations on the formation of monoglycerides and diglycerides during pancreatic lipolysis were also confirmed and considerably extended by Desnuelle and his group[14,15] and by Mattson *et al.*[16]. It is now generally accepted by workers in this field that lipolysis in the intestinal lumen is partial and not complete[17]. This was the first step towards the modern concept of the fat absorption mechanism.

In 1943 it was thought that all lipids were absorbed from the intestinal lumen, molecularly dispersed in water-soluble form. Our studies indicated that this was not necessarily the case, and that water-insoluble glycerides were also removed from the lumen of the intestine. For many years the fact that paraffins were not normally absorbed from the intestine had been regarded as strong supporting evidence for the lipolytic hypothesis, since these molecules could neither be hydrolysed by lipase nor brought into solution in water. Some absorption of paraffin had been reported, however, by earlier workers[18–21]. The quantities involved were said to be small, however, and there was no clear link with the fat absorption mechanism in these studies. In 1944 we demonstrated the absorption of paraffin administered intraduodenally to rats in finely particulate form[22]. Shoshkes, Geyer and Stare[23] obtained substantially similar results. In 1951 we reported a new series of experiments[24], which showed that paraffin could be removed from the intestinal lumen in considerable quantity, provided that it was fed in a suitable glyceride vehicle. The importance of glyceride appeared to be related to its ability to cause fine emulsification of the glyceride/paraffin mixture. The absorption of paraffin in a glyceride vehicle has been confirmed by Bernhard and Scheitlin[25]. These and a number of other investigations indicate that fine emulsification in the intestine is an important step in the removal of the water-insoluble fraction from the lumen, quite apart from any facilitating effect the fine dispersion of the oil may have on the rate of lipolysis[17].

From the outset, the work in my laboratories has been dominated by the fact that lipid molecules must be distributed between the oil and water phase in accordance with their partition coefficients. On studying the question of removal of lipid molecules from the oil into the water phase—a stage of the fat absorption mechanism that had been strangely neglected—it was soon apparent that there were considerable differences between short-chain and long-chain saturated fatty acids. These differences in partition were also reflected in differences in absorption of the corresponding glycerides—the more water-soluble fatty acids disappearing from the chyle, while the more fat-soluble molecules were retained. Some of these differences had been previously reported by other investigators[26–28]. In 1946, discussing the absorption of free fatty acid independently of the glyceride oil phase, I reached the conclusion ". . . that fat can be absorbed as fatty acid, provided that the cleavage products can be removed into the aqueous phase from the oil/water interface. This appears to be more easily accomplished in the case of butyric acid than the long-chain fatty acids. . . . It is concluded, therefore, that fat may pass by the portal vein and that this pathway is used when fatty acid is absorbed. During triglyceride absorption, it is the short-chain fatty acids which are most likely to be concerned in this mechanism"[29]. Five years later the differential distribution of short-chain and long-chain fatty acids between the chyle and portal blood was confirmed by Chaikoff and his group[30,31]. These workers were the first to provide direct proof by the use of isotope-labelled materials of the passage of fatty acids in the portal blood.

The importance of partition between the oil and water phase as a factor in the differential absorption of fatty acids and glycerides does not appear to have been fully appreciated. Thus, Bloom, Chaikoff, Reinhardt, Entenman and Dauben[32] and Bergström, Borgström, Carlsten and Rottenberg[33] appeared to expect long-chain saturated fatty acid (stearic acid) and a glyceride oil phase to be absorbed by different pathways. It would be anticipated, however, from consideration of the partition hypothesis[4,29] that there would be no such differentiation and that the lipid-soluble fatty acid would pass in the chyle. This was found to be the case.

Oleic acid was used by us in our earlier experiments because it is liquid at body temperature. Under the conditions of our experiments, differences were demonstrable during the absorption of oleic acid as compared with olive oil. Since at that time olive oil was said to be absorbed only in the form of oleic acid and glycerol, this was an additional point against complete lipolysis. It seemed likely that oleic acid might be found to be intermediate between the saturated long-chain and short-chain fatty acids in its behaviour during absorption. Since our primary objective was achieved and free fatty acids were not normal dietary constituents, we did not pursue the question of oleic acid absorption further. However, other workers—notably Tidwell[34], Singer, Sporn and Necheles[35], and recently Bergström, Blomstrand and Borgström[36], using radioactive isotope-labelled oleic acid—have done so. These investigators found that under the conditions of their experiments oleic acid behaved similarly to the long-chain saturated fatty acids and was mainly recovered from particulate fat in the chyle. They also confirmed the classical observations of Munk and Rosenstein[37] that fatty acids can be esterified in the course of absorption. Only in one group of these experiments has the state of the fatty acid in the intestinal lumen been reported[36], and in this case it was finely emulsified, so that oleic acid itself may provide the particulate oil phase. In our experiments there was no demonstrable fine emulsification of the oleic acid in the intestinal lumen and no visible emulsified fat in the chyle during the course of the experiment, so that we could only observe non-particulate absorption. The detailed study of the factors affecting oleic acid absorption might prove to be of interest in connexion with abnormal fat absorption. The evidence so far available is not incompatible with the partition hypothesis.

Thus, the conceptual changes involved in the replacement of the lipolytic hypothesis of Pflüger by the partition hypothesis are as follows :

(1) Complete hydrolysis of glycerides to fatty acids and glycerol is not an obligatory step in the process of fat absorption.

(2) Lipids do not have to be brought into water-soluble form before they can be removed from the small intestinal lumen.

(3) Eventual partition of the lipid molecules between the oil and the water phase may affect their distribution in the body after absorption.

These three basic tenets have been strongly supported by studies involving the use of isotope-labelled materials and other techniques that were not available when the hypothesis was originally formulated. The other available facts about fat absorption—such as the effect of bile salts, the mechanism and significance of intraluminar emulsification, phospholipid formation, the metabolic activity in the intestinal cells and the differential absorption of lipid-soluble molecules—can be fitted into the general framework of this partition hypothesis.

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OBITUARIES

Dr. R. C. Wallace

SCOTLAND has given many of her sons to Canada, but few, if any, have contributed as much to Canadian life as Robert Charles Wallace, who died at his home in Kingston, Ontario, on January 28, at the age of seventy-three. Recognized for many years as the doyen of Canadian vice-chancellors, he took an active part in the educational, cultural and scientific life of the Dominion. A native of the Orkneys, at the age of twenty-nine, after a university training which included undergraduate and graduate study at Edinburgh, where during 1909–10 he held an 1851 Exhibition Scholarship and was a Carnegie Fellow, a year as a demonstrator at St. Andrews, and a period in Göttingen, where he obtained his Ph.D., he went to Canada in 1910. He joined the staff of the University of Manitoba as a lecturer in geology, and after two years was made head of the Department of Geology and Mineralogy. During his Manitoba period he was Commissioner of Northern Manitoba during 1918–21 and Commissioner of Mines and Natural Resources for Manitoba during 1926–28. By 1928 the marked gifts he had shown as scientist, writer, speaker, administrator and educational leader led to his appointment in that year as second president of the University of Alberta. This post he held until 1936, when he was appointed principal and vice-chancellor of Queen's University, Kingston, Ontario. In this position he remained until his retirement in 1951.

While at Alberta and at Queen's, he combined his duties as vice-chancellor with many activities. At various times he was chairman of the Research Council of Alberta; a member of the National Research Council of Canada; chairman of the Ontario Research Commission; president of the Royal Society of Canada, of the Canadian Institute of Mining and Metallurgy, and of the Association of Canadian Clubs. He was a Fellow of the Geological Society of America, of the Mineralogy Society of America, and of the Society of Economic Geology. Towards the end of the Second World War he took an active part in the proceedings of a Federal Government Committee which led to the publication of the Wallace report on the conservation and development of Canada's natural resources. He played an important part in the founding of Unesco, being one of the original three Canadian delegates. In New York his counsel was sought and welcomed by the Carnegie Corporation.

With such a record it is not surprising that he was given honorary degrees by as many as twenty universities, among them his *Alma Mater* Edinburgh, Oxford, the Queen's University, Belfast, and Harvard.

After retirement, Wallace continued to be active until within a few months of his death. Among other things, he was an executive director of the Arctic Institute of North America, adviser to the Ontario Government on university grants, a member of the Defence Research Board of Canada, and Canadian advisory editor of the "Encyclopaedia Americana".

At Queen's, under his guidance, apart from a big increase in physical assets, such as new buildings, and the founding of such new teaching 'schools' as nursing, industrial relations and local government, there was a marked increase in research in science

and in medicine, and in the humanities high scholarship was stimulated. In making new appointments, although he insisted on high professional qualifications, he sought also men of character and culture, believing, to quote his own words, that "no teachers can conceal their characters and outlook on life from a class".

Unbending as granite where ethical principles were concerned, Wallace listened gladly to views opposed to his own and was kind to people in all walks of life. His office door was open, literally and metaphorically, to members of staff and students alike. Like most Scots, he made no outward display of the sentiment which lay below the surface. But only a few months before his death, on the occasion of the centenary of *The Orcadian*, he wrote with feeling of "scenes of cliff and sea and sky" and of "that indescribably soft ethereal light at or near midnight on summer's longest days in the Orkneys", things which were caught "indelibly in memory".

He is survived by his wife, Elizabeth Smith, also a native of the Orkneys, whose graciousness and natural charm added greatly to the warm welcome given the many who went to the principal's residence on Queen's University grounds. Three daughters, Mrs. D. E. Woodsworth, Mrs. H. W. Addington and Mrs. Charles Baugh, also survive. A son, Ronald, died in 1936. J. K. Robertson

Mr. G. W. Grabham, O.B.E.

George Walter Grabham was born in 1882 in Madeira, where his father, Dr. Michael Grabham, was a well-known resident. Educated at University College School and at St. John's College, Cambridge, he joined the Geological Survey of Great Britain in 1903 and worked in Scotland until 1906. He then followed T. Barron as Government geologist in the Anglo-Egyptian Sudan. There, throughout his service, he travelled widely, on foot and by river, with camels and with both early and modern motor transport. He was mainly concerned with the most vital need—water; and in his journeys and special investigations he gathered a unique knowledge of the geology of the country. By far the greater part of his work is represented by unpublished reports in the Geological Survey office in Khartoum. He was also closely interested in the people's agricultural and other pursuits, past and present, and was acting conservator of antiquities.

Outside the Sudan he made extensive journeys, about which little was heard, in inter-tropical Africa; he was best known for his official mission to Lake Tana (with R. P. Black, 1920–21).

Grabham retired from the Geological Survey of the Sudan in 1934, but was retained as geological adviser until 1939. After the Second World War he wintered in the Sudan, maintaining vigorously his many and varied personal interests.

In Madeira he inherited his father's house, where his affection for the island, and all that it implied for him, was widely known. To the end he made exacting walks in that land of profound cliffs and gorges. Here, as in the Sudan, he took unflagging pleasure in showing others the country, either on the ground or with the aid of his vast collection of photographs and lantern slides; his hospitality was proverbial.

He was a familiar figure at international geological congresses, and on their long field excursions, in many parts of the world, and for many years his annual visit to Britain coincided with the meeting of the British Association, at which he enjoyed meeting his friends; latterly he came to his clubs in London twice a year, and made a tour of his diminishing circle of relatives and close associates.

To many, Grabham seemed a lonely man, but he delighted in company; a rather forbidding figure, but he had an inexhaustible fund of humour; of his sympathy and kindness the sum will never be told. His end was as he would probably have wished; he was about to lecture to a cultural meeting in Khartoum, but, feeling unwell, took his leave and bicycled home to his house in Burri Village, where he was found dead the following morning. So passes a great figure. K. S. Sandford

Dr. W. M. Ware

Former colleagues have experienced a deep sense of loss following the sudden death, on February 15, of William Melville Ware at the age of sixty-two. Particularly has the loss been felt by many present and past members of Wye College (University of London), for it was there that all his scientific work was done.

Ware entered Wye College in 1911 as a student, after receiving a grounding in the classics at Dover College, followed by a period in an academy at Le Havre, where he attained fluency in French. During the First World War he was on active service with the Army and on demobilization returned to Wye as a lecturer in botany. Research, however, was his *métier*; while still a lecturer he investigated problems of clover with a grant from the Ministry of Agriculture, and this led to the publication of several papers on the subject and on certain diseases of other plants.

In 1923 he accepted an invitation to join the Mycology Department (Research and Advisory) under the direction of Prof. E. S. Salmon. For the next twenty-three years his investigations formed a major stimulus to the growth of the young science of plant pathology.

His main researches were on diseases of fruit, hops and mushrooms; but other horticultural and agricultural crops also received attention, and about a hundred original papers of high quality appeared under his name, either alone or jointly with colleagues. His researches into apple scab (*Venturia inaequalis* (Cooke) Wint.) and hop downy mildew (*Pseudoperonospora humuli* (Miyabe and Tak) G. W. Wilson) are particularly outstanding, while his observations on the cultivated mushroom led not only to the discovery of crop-reducing diseases, but also to the writing of a bulletin on mushroom-growing for the Ministry of Agriculture. Following his first degree of B.Sc. (Agric.), he was awarded the M.Sc. in 1923 and the D.Sc. in 1935.

Ware followed Prof. Salmon as head of the Mycology Department at Wye in 1937, and directed research and advisory work through the difficult war years; but the decision to absorb the Department into the Civil Service prompted his retirement in October 1946.

Ware served on the Council of the Association of Applied Biologists and as a member of the Plant Pathology Committee of the British Mycological Society; but his distaste for committee work debarred him from seeking office in the learned societies. His contributions to science are familiar to

plant pathologists throughout the world and, had his ambition equalled his ability, high academic rewards would undoubtedly have been his.

In retirement, gardening and travel were among his chief delights; but since 1948, as assistant editor of the *Journal of Horticultural Science*, he had kept in touch with current research.

Although modest and reserved to an unusual degree, Ware's attractive personality brought him a wide circle of friends, and many of those who knew him best have reason to be grateful for his help and for his counsel, which was sought by his seniors as well as by his juniors. He leaves a widow.

H. H. Glasscock

NEWS and VIEWS

Research in the Physics of Solids: Prof. A. H. Cottrell

Prof. A. H. Cottrell, of the Department of Physical Metallurgy, University of Birmingham, has accepted an appointment with the U.K. Atomic Energy Authority, at the Atomic Energy Research Establishment, Harwell, as deputy head of the Metallurgy Division and leader of a group engaged in research on the physics of solids. He will be taking up his new appointment in April. Prof. Cottrell, who is thirty-five, is a graduate of the University of Birmingham. During 1939–45 he was engaged in research on the welding of tank armour. He was appointed a lecturer in metallurgy in the University of Birmingham in 1943. When the late Prof. Hanson, immediately after the War, was re-organizing teaching and research in metallurgy at Birmingham, one of his principal objects was to create a strong school of theoretical and physical metallurgy. The Department of Scientific and Industrial Research gave substantial support for an initial period, and with notable vision Prof. Hanson recommended the University to create two new professorships, one in physical metallurgy and the other in metal physics. Accordingly, in 1949 Dr. Cottrell and Dr. G. V. Raynor, then reader in theoretical metallurgy, were appointed to the new chairs. On the death of Prof. Hanson in 1953, Profs. Cottrell and Raynor were made joint heads of the Department of Physical Metallurgy.

Prof. Cottrell's researches have been mainly concerned with the plastic deformation of metal crystals. In ample justification of Prof. Hanson's hopes, he and the group of able young men whom he has gathered around him have done much to establish Britain's leading position in this field of research. Prof. Cottrell has travelled extensively—he made lecture tours in the United States in 1950 and 1953 and was guest lecturer at the University of the Witwatersrand in 1952 and at the University of Louvain in 1953. He attended the Ninth International Solvay Conference on Physics at Brussels in 1951, and delivered the 1953 R. S. Williams Lectures at the Massachusetts Institute of Technology. He was awarded the Rosenhain Medal by the Institute of Metals in 1954. Prof. Cottrell has acted as chairman of the Basic Properties Committee of the Inter-Service Metallurgical Research Council, and is also associate editor for Great Britain of *Acta Metallurgica*.

Psychology at Glasgow: Prof. R. W. Pickford

Prof. Ralph William Pickford, who has been appointed to be the first incumbent of the recently created chair of psychology in the University of Glasgow, has been associated with the Department of Psychology at Glasgow for more than twenty-five years. His first appointment there was in 1930 as assistant to Dr. R. H. Thouless, becoming lecturer in 1935 and senior lecturer and head of the Department in 1948. Dr. Pickford was a student at the then Southampton University College before proceeding in 1923 to Emmanuel College, Cambridge, where he graduated in psychology and obtained his Ph.D. in 1932. During 1927–32, with a grant from the Vision Committee of the Medical Research Council, Prof. Pickford undertook research on the psychology of reading. His publications include a monograph, two books, and many papers and articles dealing especially with experimental studies of colour vision and visual perception, and with the psychology of art and social and clinical psychology. He has been president and is retiring secretary of the Scottish Branch of the British Psychological Society, and was a founder member and the first president of the Experimental Psychology Group. For ten years he has worked in a voluntary capacity at the Notre Dame Child Guidance Clinic, at the Davidson Clinic, Glasgow, and as a counsellor for the Glasgow Marriage Guidance Council. He is keenly interested in music.

Sir George Beilby Memorial Awards, 1954

The administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have made awards from the Fund for 1954, each of one hundred and fifty guineas, to Dr. H. K. Hardy and to Dr. J. W. Menter. The awards are made to British investigators for work in such fields as fuel economy, chemical engineering and metallurgy, in which Sir George Beilby's special interests lay, and in general they are given to relatively young scientists for work over a period of years.

Dr. H. K. Hardy's award is for work in physical metallurgy, with special reference to precipitation hardening and to the thermodynamics of phase equilibria in alloy systems. He graduated in metallurgy from the Imperial College of Science and Technology, London, in 1940, and afterwards, while at the Research Department of the Northern Aluminium Co., Ltd., and at Aluminium Laboratories, Ltd., he was concerned with the metallography of duralumin-type alloys and the development of high-strength aluminium–zinc–magnesium alloys, particularly the nature of the extrusion process and the microstructural effects associated with the onset of overheating. In 1946 he joined the Fulmer Research Institute as head of the Physical Metallurgy Section and later as senior metallurgist, where he investigated the precipitation process in aluminium–copper alloys over a wide range of supersaturations and with the addition of small quantities of other elements. The thermodynamics of this and other phase equilibria in alloy systems have been closely studied.

Dr. J. W. Menter entered Peterhouse, Cambridge, and after governmental war-time service graduated in physics in 1945. His Beilby award is for work on surface phenomena, with special reference to the

application of electron optical techniques to the elucidation of a wide range of problems; and this work commenced at Cambridge in the Research Laboratory for the Physics and Chemistry of Surfaces, Department of Physical Chemistry, with a study by electron diffraction of the orientation of long-chain hydrocarbon compounds on metal surfaces. He has applied electron optical techniques to metallurgical problems, and more recently he has adapted a transmission electron microscope for use as a reflexion instrument and investigated a wide range of surface phenomena. Dr. Menter is at present working in the Tube Investments Research Laboratories, Hinxton Hall.

Royal Society of Edinburgh: New Fellows

The following have been elected Fellows of the Royal Society of Edinburgh: Mr. W. Anderson, district geologist, Geological Survey of Great Britain; Dr. D. J. Bell, senior principal scientific officer, Poultry Research Centre, Edinburgh; Dr. W. A. P. Black, head of the Chemical Division of the Institute of Seaweed Research, Musselburgh; Dr. P. H. Davis, lecturer in the Department of Botany, University of Edinburgh; Dr. W. A. Fairbairn, lecturer in the Department of Forestry, University of Edinburgh; Dr. D. J. Finney, reader in statistics, University of Aberdeen; Dr. P. G. Fothergill, lecturer in botany, University of Durham; Principal T. M. Knox, University of St. Andrews; Mr. J. Kyles, lecturer in the Department of Natural Philosophy, University of Edinburgh; Prof. A. M. Macbeath, Department of Mathematics, Queen's College, Dundee; Mr. D. H. McIntosh, superintendent of the Observatory, Eskdalemuir, Dumfriesshire; Sir James Miller, managing director of James Miller and Partners, Ltd.; Dr. N. Miller, senior lecturer in radiochemistry, University of Edinburgh; Dr. G. H. Mitchell, district geologist, Geological Survey of Great Britain (Edinburgh Office); Dr. R. L. Mitchell, head of the Department of Spectrochemistry, Macaulay Institute for Soil Research, Aberdeen; Prof. S. D. Nisbet, Department of Education, University of Glasgow; Dr. A. E. Oxford, head of the Department of Microbiology, Rowett Research Institute, Aberdeen; Dr. H. S. A. Potter, senior lecturer in the Department of Mathematics, University of Aberdeen; Mr. K. A. Pyefinch, Brown Trout Research Laboratory, Pitlochry; Prof. R. A. Rankin, Department of Mathematics, University of Glasgow; Dr. G. A. Reay, superintendent of the Torry Research Station, Aberdeen; Prof. G. J. Romanes, Department of Anatomy, University of Edinburgh; Prof. A. B. Stewart, Department of Agriculture, University of Aberdeen; Mr. H. B. Sutherland, senior lecturer in civil engineering, University of Glasgow; and Dr. D. Taylor, lecturer in chemistry, University of Edinburgh.

C. V. Boys (1855–1944): Centenary Exhibition in London

The Science Museum, London, is commemorating the centenary of the birth of Sir Charles Vernon Boys (1855–1944) by a special display of instruments drawn from the permanent collections. The exhibition will be open for a period of three months, commencing on March 15, Boys's birthday. Of his manifold activities in the field of experimental physics, Boys is probably best remembered for his work on the production and properties of exceedingly fine quartz fibres. The fibres were used in the construction of a very sensitive radio-micrometer which, aided by a reflecting telescope, was capable of detecting radiation as feeble as that from the flame of a candle at a distance of almost three miles. The elastic properties of quartz fibres were also utilized by Boys in designing a torsion balance with which he determined the Newtonian constant of gravitation and the mean density of the earth with an accuracy previously unattainable. In addition to the original radio-micrometer and gravitational apparatus, the exhibits include Boys's lightning camera, his gas calorimeter and a number of mathematical instruments.

Optimum Use of Scientific Workers in Great Britain

In announcing in the House of Commons on March 10 the Government's acceptance of the recommendations of the Burnham Committee for the payment of special allowances to teachers of advanced work, Sir David Eccles, the Minister of Education, said that at the request of the Government the Federation of British Industries has sent a circular to the seven thousand individual firms and three hundred trade associations comprising its membership asking them to exercise restraint in bidding against the schools for science graduates. The circular states that, in discussions with the Government on the shortage of science teachers, it was pointed out to the Federation that a hopeless situation would arise if the increased remuneration for teachers was countered by a corresponding raising of salary levels by industry. The Federation agreed to put this point to its members, and the circular suggests that in this connexion firms could also review the use they make of scientific staff so as to reserve such staff for the really essential work for which they are best fitted. It is suggested that, in addition, some relief could be obtained by retaining scientific staff beyond the normal retiring age and that, if firms could help to encourage greater numbers of suitable and able boys to remain at school for a further period, both industry and the schools would ultimately benefit from an increased number of science graduates. The circular also states that the Government is reviewing the whole question of scientific workers in the public service so as to ensure that the best and most economical use is made of them in the national interest.

Chalk Lime and Allied Industries' Research Association

The first general meeting of the Chalk Lime and Allied Industries' Research Association was held on March 9 in the Association's offices at Hanover House, 73–78 High Holborn, London. The preliminary work leading to the establishment of this, the latest of the research associations to be formed under the ægis of the Department of Scientific and Industrial Research, was done by the members of the Southern Lime Association. As indicated by its title, the new Association will conduct co-operative research for the chalk lime and allied industries. At the meeting, Mr. W. L. Clarke was elected chairman of the Association and Mr. M. W. Hall as vice-chairman. Mr. G. E. Bessey has been appointed director of research and has already taken up his appointment. Mr. Bessey was previously director of research of the Research Council of the British Whiting Federation and before 1949 was on the staff of the Building Research Station. Negotiations are

at present in progress for a site for laboratories and for temporary accommodation until new laboratories can be built.

University of London

THE following appointments have been made in the University of London: Prof. L. J. Kastner, professor of engineering and head of the Engineering Department, University College, Swansea, to the University chair of mechanical engineering tenable at King's College; Dr. E. A. Wright, experimental pathologist at the Medical Research Council's Experimental Radiopathology Research Unit, Hammersmith Hospital, to the University readership in pathology tenable at St. Mary's Hospital Medical School. The title of reader in electrical engineering in the University of London has been conferred on Dr. A. L. Cullen in respect of his post at University College, and that of reader in mathematics in the University of London on Dr. Winifred L. C. Sargent in respect of her post at Bedford College.

Postgraduate Awards in Agricultural Research

THE Agricultural Research Council has recently issued a useful booklet giving details of the training grants, research studentships and fellowships which the Council is offering this year. The booklet also gives information about the openings in the agricultural research and advisory services. Two veterinary research fellowships of £850 a year plus superannuation, and tenable for three years, will be open to workers holding a veterinary qualification who have had not less than three years of experience in veterinary research; and three junior agricultural research fellowships of £630 a year plus superannuation, and also tenable for three years, will be open to honours graduates with not less than three years of postgraduate experience. In addition, the Council is again offering up to thirty postgraduate training grants and research studentships in agricultural and veterinary science, applications for which should reach the Council by March 31. A copy of the booklet, free of charge, and further information can be obtained from the Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1.

Efficiency of the Individual Worker: Conference in Cambridge

A RESIDENTIAL conference, to be held in Cambridge during March 31–April 3, has been arranged by the Medical Research Council with the object of discussing the latest results of research directed to improving the efficiency of the individual worker. Sir Geoffrey Vickers will take the chair, and about a hundred and fifty delegates from industry and research establishments are expected. The subjects to be discussed will include the effects of environment on working capacity, the design of machinery in relation to the operator, the effects of continued or prolonged work on individual efficiency, industrial training problems, and the use which is made of research results. In addition, there will be a short film, followed by a discussion, showing the way in which psychological processes and principles have relevance in daily life and industrial production. Practical demonstrations, including working models illustrating the research work which has been carried out, will also be shown. Further information can be obtained from the Medical Research Council, 38 Old Queen Street, London, S.W.1.

Announcements

THE following Royal Society Lectures will be given this year: Croonian Lecture on June 16, by Prof. C. H. Best (University of Toronto), speaking on dietary factors in the protection of the liver, kidneys, heart and other organs in experimental animals—the lipotropic agents; and Bakerian Lecture on April 28, by Prof. M. L. E. Oliphant (Australian National University, Canberra), speaking on the acceleration of charged particles to very high energies.

THE Medical Research Council is offering four Eli Lilly travelling fellowships and one Lederle travelling fellowship for work in the United States during the academic year 1955–56. The fellowships, which are worth 2,700 dollars (3,900 for a married man), are for graduates resident in Great Britain trained in research work in clinical medicine or surgery or some other branch of medical science. Application forms, to be returned by March 28, and further information can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

THE annual conference of the Oil and Colour Chemists' Association will be held this year in Llandudno during June 7–11, and the subject for discussion will be "Film Structure and Adhesion". The conference is open to non-members. Registration forms, to be returned by April 1, and further information can be obtained from the general secretary, R. H. Hamblin, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

THE spring meeting of the Optical Society of America will be held in the Hotel Statler, New York City, during April 7–9, and will include a special symposium on optical molecular spectroscopy. On April 8 the Edgar D. Tillyer Medal of the Society will be presented to Prof. Adelbert Ames, jun. The meeting will be open to non-members of the Society. Further information can be obtained from the secretary of the Society, Arthur C. Hardy, Massachusetts Institute of Technology, Cambridge 39, Mass.

A CONFERENCE on starch, organized by the Arbeitsgemeinschaft Getreideforschung in conjunction with the Fachverband der Stärkeindustrie, will be held in Detmold, Germany, at the Roemer-Haus of the former organization during April 26–28. The programme will be in four parts—fundamental research, research methods, starch production and techniques, and starch derivatives. Of the twenty-two speakers, fourteen will be from outside Germany. Further information can be obtained from the Arbeitsgemeinschaft Getreideforschung e.V., Am Schützenberg 9, Detmold.

THE Association of Agriculture (52 Victoria Street, London, S.W.1) is arranging a course on "World Food: an Illustrated Study in Biology and Geography", to be held in Westham House Adult Residential College, Westham House, Barford, Warwick, during May 27–31. The fee for the course, which is fully residential, is £3 12*s.* 6*d.* Application should be made to Captain Frank Owen at Westham House.

THE annual general meeting of "Science for Peace", followed by a public conference on "Nuclear Explosions—their Long-term Effects", will be held in the Holborn Assembly Hall, John's Mews, London, W.C.1, on March 26. Further information can be obtained from the Honorary Secretary, Science for Peace, 16 Ulster Place, London, W.C.1.

BIRKENHEAD TECHNICAL COLLEGE

THE foundation stone of the new Technical College at Birkenhead was laid on May 3, 1950, by Her Majesty the Queen, now Queen Elizabeth the Queen Mother, and the College was opened officially on January 8 last by Sir Henry Cohen, a former student of Birkenhead schools who has reached eminence in his chosen profession of medicine.

The building is in the form of a letter H, one limb of which is six stories high and includes the class-rooms, drawing offices, library, administrative offices, and staff and student common rooms. The limb at right angles to this is termed the 'Spine Block' and is of five stories housing the electrical engineering and science laboratories and domestic craft rooms, and the top floor is devoted to the College refectory and kitchen. The other limb, parallel to the classroom block, forms the workshop block, which is a single-story structure.

The building is steel-framed, encased in concrete with pre-cast concrete floors. It is faced with wire-cut bricks with the exception of the centre of the front, which is faced with Westmorland rough-hewn slate. The building is in three sections with expansion joints. Gauges have been fitted to show the seasonal movement. The total floor area of the College is approximately 250,000 sq. ft.

At the north end of the classroom block is the hall, which will seat approximately 1,000 and is fully equipped for theatrical purposes and can be separated from the main building for use by outside cultural organizations. There is also a gymnasium.

The College is organized in the following departments: building, commerce, domestic science, electrical engineering, mechanical engineering and science.

The building was opened for instructional purposes in September 1954, and the enrolments at the moment are more than 3,600, of whom approximately 200 are full-time, 1,100 day-release, and 2,300 evening students.

The various departments are offering a wide range of courses, including national certificate, higher national certificate and craft courses. Thus in the Department of Building, in addition to ordinary national certificates in building, there are City and Guilds courses in brickwork, carpentry and joinery, plumbing and ships' plumbing. The Department of Commerce provides courses for national certificates in commerce, secretarial and commercial courses, intermediate and final examination courses for the various professional institutions. Ordinary and higher national certificate courses, together with City and Guilds courses in electrical installation, telecommunications and radio servicing, are offered in the Department of Electrical Engineering. In the Department of Mechanical Engineering there are courses for ordinary national diploma in mechanical engineering for seagoing engineers, ordinary and higher national certificates in mechanical engineering with endorsement subjects, ordinary and higher national certificates in naval architecture, together with craft courses in workshop practice, motor vehicle mechanics' work, sheet and plate metal work, welding, and foundry practice. In the Department of Science there are courses for ordinary and higher national certificates in chemistry, an intensive full-time course for, and part-time courses leading to, the examination for the associateship of the Royal Institute of Chemistry, a full-time intermediate

Birkenhead Technical College

pharmacy course, and a number of short courses on glass-working, instrument technology, etc., and an ordinary national certificate course in metallurgy.

The College is also recognized for the award of the higher national certificate in chemical engineering.

The Domestic Studies Department covers a wide range of examination courses leading to the award of the City and Guilds or Union of Lancashire and Cheshire Institutes' certificates in cookery, dressmaking, needlework, tailoring, upholstery, and the Educational Development Association certificates in basketry. Bakery courses were started in September in preparation for the City and Guilds intermediate examination in bread-making and flour confectionery. Catering courses include the catering trades basic training course (City and Guilds), cookery for hotels and restaurants (City and Guilds), and catering for non-residential licensed houses.

The total accommodation in the College, apart from the administrative offices, consists of forty-two classrooms, five lecture theatres, sixteen laboratories, three commerce rooms, geography room, three domestic study rooms, three craft rooms, ten workshops, a bakery and a butchery.

The first principal of the College, Mr. C. V. Vinten Fenton, has a staff of forty-two full-time and two hundred part-time teachers. Mr. Fenton, before going to Birkenhead, was the first principal of the Peterborough College; there he was responsible for organizing technical education and saw the completion of the first phase of the new technical college built in that city.

ASLIB SCOTTISH BRANCH

ANNUAL MEETING

THE annual general meeting and one-day conference of the Scottish Branch of Aslib (Association of Special Libraries and Information Bureaux) was held in the Mitchell Library, Glasgow, on February 11. The first paper of the morning was given by Dr. B. J. A. Bard, industrial manager of the National Research Development Corporation. He spoke of the work of the Corporation since its inception in 1950 and described its function as the development and exploitation, in the public interest, of inventions resulting from research carried out by government departments and other public bodies, and private inventions where they are of primary importance to the public interest. Dr. Bard outlined the organization of the Corporation, described how inventions are exploited and developed, and gave a general description of some of the projects in hand.

Following this paper, there was a symposium on the treatment and circulation of periodicals. The first speaker was Miss E. Handlen, librarian of the Department of the Secretary of State for Scotland. She said that, whatever the scope of a library, two demands are common to all: users want to see articles as soon as they are published, and they want to go to the library and find articles to help with a problem. Dealing with up to two thousand titles received by the Department of the Secretary of State for Scotland, these are sorted and the date of arrival recorded, and they are then circulated according to simple circulation slips made up so that the most senior officers have priority.

In this way, periodicals are circulated around seven hundred chosen users, although this figure should be trebled because officers on the lists show important articles to their juniors. All, or nearly all, periodicals are brought back to the Library, preferably before a new issue arrives. To help in this circulation, the Library has specially printed cards arranged alphabetically in a tumble-card cabinet with spaces on the face for the date entries, and other more permanent information on the back (the circulation, start of run, binding, etc.). This permits 'flagging' any item which needs special attention. One man can handle the work. It sometimes happens that a periodical circulated to medical men may contain an article of value to, say, a sanitary engineer. The supplementary service for these fits into the general circulation scheme; the first name on circulation lists is that of the librarian, and Miss Handlen includes the odd articles in the accessions lists, so that officers who have missed circulations can borrow. Such cases amount to less than ten in one month. There may be about the same number of important articles meriting inclusion in the subject card-index.

Miss Handlen favours duplication of purchase in the case of periodicals of ephemeral interest, since this permits retention of one master set and cutting of the other copies, thus saving time and labour in copying. She emphasized that circulation of periodicals is necessary where there are 700 users and 29,000 issues, and that display and retention in the library would be quite impracticable. Even in a smaller library, the display system would lead to loans, and loans are not as quick as circulations and are more costly in staff time. Full indexing of articles is not possible, and Miss Handlen said that full indexing often seems to defeat its own ends, being extremely cumbersome and costly for small results. Finally, she asked if there is not a danger of a librarian coming too much between the user and the holdings. She felt that librarianship is in danger of becoming an esoteric clerical job if too much is attempted in the way of carding every reference. Miss Handlen said that she would rather contribute £25 a year to an abstracting journal to help it become more efficient and up to date in publication than pay £500 to an extra assistant to anticipate the abstracts.

The second speaker in the symposium was Mr. A. Liddle, librarian to the firm of Babcock and Wilcox, Ltd., who described the controlled circulation of a hundred and forty periodical titles to approximately a hundred and twenty readers, most of whom are within the firm's research station. The circulation slips affixed to the periodical have columns for name, department, see pages, date sent, returned and initials. A section is provided for readers to note that they wish pages to be abstracted and indexed in the central file. Normally, periodicals are displayed for seven days so that anyone can add their name to the circulation list, or delete it if it is already there and that issue is not of further interest. Mr. Liddle thought that the time necessary for recording is justifiable by results and described the visible card system used. To help in the service of getting information to users as quickly as possible, the periodicals are first scanned and items of current interest are abstracted and produced in the form of a weekly bulletin.

The third speaker in the symposium was Mr. J. R. K. Pirie, librarian of the Mechanical Engineering Research Laboratory, East Kilbride, of the Department of Scientific and Industrial Research. He outlined the difficulty of circulating three hundred and

fifty periodicals to staff housed in several buildings, one set being more than four miles from the main central library. The staff have been asked which periodicals they wish to see, and only nineteen were asked for by more than eight readers; circulation lists were then drawn up. Periodicals are normally displayed for seven days, allowing members of staff to scan and delete their names from the lists if there is nothing of interest. Circulation priority is arranged into the categories of 'urgent', 'personal' and 'departmental'. The system of recording is that described by its designer, Miss Ruth Jacobs (then of the Department of Scientific and Industrial Research), in the *Journal of Documentation*, 6 (4), 213 (1950). Names of borrowers are grouped, so that periodicals are returned to the library after every three or four names for checking.

The afternoon session was devoted to a paper by Mr. F. W. Gravell, librarian of the Patent Office. He spoke of the purpose and process of patenting an invention, and described the scope and work of the Patent Office Library. The full text of the papers by Dr. Bard and Mr. Gravell will be published in *Aslib Proceedings* in due course. Margaret Spence

LINEN INDUSTRY RESEARCH ASSOCIATION

At the thirty-fifth annual general meeting of the Linen Industry Research Association on December 17, 1954, both the chairman, Mr. H. B. McCance, and Mr. N. V. Cooke, in proposing and seconding the motion to adopt the report of the council and the accounts, stressed the importance of making sure that the industry gets the best value for the expenditure of £70,000 a year on research. Mr. McCance urged that research should be concentrated on a few well-defined objectives of such importance that the industry would at once provide the whole of the money required if the government contribution were withdrawn. Mr. Cooke emphasized the importance of securing staff of outstanding ability and especially with imagination, at least some of whom should come from outside the industry. This point was welcomed by the director of research, Dr. A. J. Turner, who also stressed the value of those of the staff who had been appointed for their technical knowledge and experience. Most of the present staff had come to the Association with no previous knowledge of textiles; but the Association is still trying to obtain one or two more senior men of the type Mr. Cooke considers necessary.

In reviewing the year's work, Dr. Turner said that we are in the throes of a new industrial revolution arising out of the modern advances in physics and chemistry. In so far as the linen industry is still a craft industry, a great struggle is involved in trying to prevent it from shrinking further in competition with the man-made fibres. It will be necessary to attempt to process specially selected man-made fibres on flax machinery to obtain special effects and novelties. The linen industry of the future can be transformed so as to include the man-made staple fibres, and unique blends of such fibres with one another or with flax can be made into new and readily saleable cloths. Little work is at present being done by the Association on flax production. In the spinning departments the most interesting fundamental research is that on yarn irregularity. Dr. Turner also referred to the value of starch ethers and cellulose ethers as sizing agents for linen yarns; but the advances in polymer chemistry have been most keenly felt in the chemistry department, particularly as regards special proofing finishes, and the possibilities are far from being exhausted.

The report of the Council of the Linen Industry Research Association for the year ended September 30, 1954*, records a slight fall in membership, from 285 to 281, and regrets also the decision by the Government to terminate, on economic grounds, the Home Flax Production Scheme. There has also been a large contraction in the flax acreage in Northern Ireland, where tank retting has almost ceased, and in consequence research work on tank retting problems has been suspended. Research work on spinning has resulted in mechanical modifications for improving the operation of drawing frames and in recommendations for improving the control of yarn quality and the efficiency. A new system has been developed for controlling the levelness of drafting, and the study of the strength relation of yarns and cloths has enabled the necessary yarn strengths to be predicted when making cloths of certain specification. A new test has been devised for measuring the absorbency of cloth during the first few seconds of contact with a wet surface, and promising results have been obtained in factory trials with some new sizing materials. A prototype production model of the new spool winder, which makes packages suitable for overend unwinding, is now being built; much attention has been given to proofing linen fabrics, and improvements have been made in waterproofing flax canvases with pigmented drying oils and with oils and waxes applied from emulsions.

* Linen Industry Research Association. Report of the Council, 1954. Pp. 20. (Belfast: Linen Industry Research Association, 1954.)

APPARENT HETEROGENEITY OF DEOXYRIBONUCLEIC ACID: SEDIMENTATION EXPERIMENTS AT LOW CONCENTRATIONS

By Dr. K. V. SHOOTER and Prof. J. A. V. BUTLER

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Sedimentation experiments with deoxyribonucleic acid, using the Philpot–Svensson[1] optical system, can be carried out at concentrations down to 5×10^{-4} gm./ml. Although at this concentration only a slight spreading of the peak is observed[2], this cannot be taken as an indication of the homogeneity of the material, since it is known from light-scattering measurements[3] that interaction between the molecules only becomes small at concentrations less than 3×10^{-3} gm./ml. The strong absorption in the ultraviolet shown by solutions of deoxyribonucleic acid can be used to measure the rate of sedimentation at concentrations down to 10^{-5} gm./ml. The results discussed in this communication refer to various dilutions of three different stock solutions prepared from one preparation (DNA7)[4]. 0·02–0·04 per cent of deoxyribonucleic acid was dissolved in water for twenty-four hours and then diluted with an equal volume of 0·4 *M* sodium chloride. These solutions

were then further diluted with 0·2 *M* sodium chloride to obtain the very low concentrations used. The experiments have been carried out with the 'Spinco' model *E* ultracentrifuge fitted with an ultra-violet absorption observation system working in the wavelength region 248–265μ.

We have found that at concentrations of deoxyribonucleic acid less than 1×10^{-4} gm./ml. the boundary shows a very marked degree of spreading. The essential problem at these low concentrations is to determine whether this is due to the inherent instability of the boundary, or whether it corresponds to a real heterogeneity of sedimentation coefficients. We have used two criteria to determine whether the boundary is stable.

First, the calculated sedimentation coefficients should be reproducible and should increase steadily as the concentration of deoxyribonucleic acid is reduced. As is shown in Fig. 1, the reproducibility of the results is of the order of ± 10 per cent. At concentrations less than 5×10^{-5} gm./ml. the sedimentation coefficients are somewhat lower than expected, and this and other evidence given later suggests that at such concentrations the boundary is not stable. The mean sedimentation constant at zero concentration is about 24 *S*. This value is higher than has been previously found by extrapolation from results obtained at higher concentrations[2,3,5].

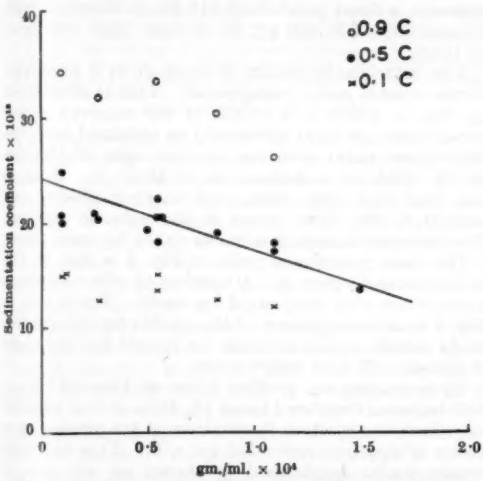

Fig. 1. Variation of the sedimentation coefficient with concentration: deoxyribonucleic acid in 0·2 *M* sodium chloride

A second and more definite criterion that we have used is to determine whether the spreading of the boundary, in terms of sedimentation coefficients, changes with time of sedimentation. When sedimentation begins, the boundary is at the meniscus (a distance x_0 from the centre of rotation), and is infinitely sharp. After a time of sedimentation (t), the distance from the centre of rotation to points in the boundary where the concentration is 0·1, 0·5 and 0·9 of the total concentration has been measured (x). If the boundary remains undisturbed during sedimentation, then a plot of log x versus t should give a straight line for each concentration, and the three lines should extrapolate to a point at log x = log x_0. It has been found that at concentrations down to 5×10^{-5} gm./ml. deoxyribonucleic acid this test shows that the boundary is stable (Fig. 2). At

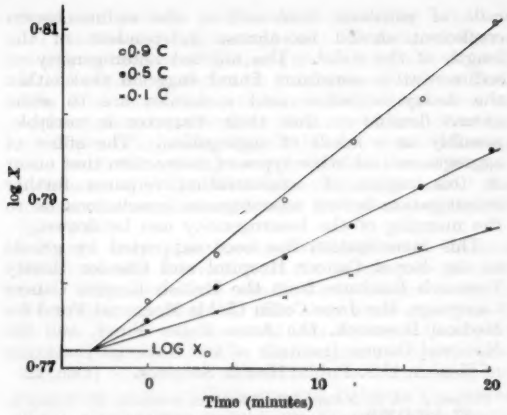

Fig. 2. $5 \cdot 5 \times 10^{-4}$ gm. deoxyribonucleic acid/ml. in 0·2 *M* sodium chloride: the slopes of the lines give the sedimentation coefficients for concentrations 0·1, 0·5 and 0·9 times the total concentration

lower concentrations, although the points fit straight-line plots fairly well, the three lines do not converge to a point at log x_0. The main cause of the instability of the boundary will be the stirring effects of thermal currents, and these will be most marked during the adiabatic cooling of the rotor during acceleration[6,7]. These results also show that the spreading due to diffusion is negligible in these experiments.

These results have been further analysed to determine the distribution of sedimentation coefficients. From the photographs taken during sedimentation, the plot of optical density of the solution versus distance down the cell is obtained. This can be transposed to a plot of optical density versus sedimentation coefficient, and the first derivative of this curve gives an apparent sedimentation distribution. The correction for dilution resulting from sedimentation in a sector-shaped cell is applied at this stage[6]. Fig. 3 shows the distribution diagrams obtained for solutions containing 11 and $5 \cdot 5 \times 10^{-5}$ gm./ml. deoxyribonucleic acid. It is obvious that the deoxyribonucleic acid preparation is extremely heterogeneous. If it is assumed that for each molecular species the absorption is proportional to concentration, then the ordinates of Fig. 3 give the weight-fraction of the deoxyribonucleic acid having a particular sedimentation coefficient. Comparison of the shapes of the two distributions in Fig. 3 shows that at 11×10^{-5} gm./ml. some self-sharpening of the boundary due to the Johnston–Ogston[8] effect occurs, whereas at the lower concentration there is no obvious self-sharpening of the boundary. Since, however, interaction may still occur at the lower concentration, the curve of Fig. 3 may not represent the true distribution of sedimentation constants. It may be noted that for a system consisting of rigid

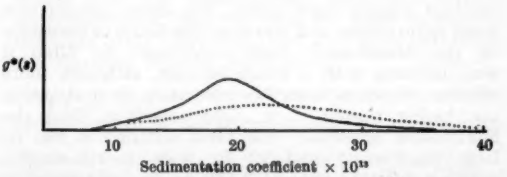

Fig. 3. Apparent distribution curves for deoxyribonucleic acid; full line, 11×10^{-5} gm./ml.; dotted line, $5 \cdot 5 \times 10^{-5}$ gm./ml.

rods of constant cross-section, the sedimentation coefficient should be almost independent of the length of the rods[3]. The marked heterogeneity of sedimentation constants found suggests that either the deoxyribonucleic acid molecules are to some extent flexible or that their diameter is variable, possibly as a result of aggregation. The effect of aggregation and other types of interaction that occur in this region of concentration requires further investigation before unambiguous conclusions as to the meaning of the heterogeneity can be drawn.

This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Services. [Dec. 22

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DISTRIBUTION OF RADIO BRIGHTNESS ACROSS THE ANDROMEDA NEBULA

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USING the 96-helix antenna and improved receiver of the Ohio State University radio telescope (Kraus and Stoutenburg, in preparation), observations have been made of the radio brightness across the Andromeda nebula (*M*31) at 250 Mc./sec. A radio source near the nebula's position was detected by Ryle, Smith and Elsmore[1] at Cambridge about 1950. However, it remained for Hanbury Brown and Hazard[2] at Manchester in 1950 to make the first positive identification of a radio source with the nebula. Their observations stand as an epic achievement of radio astronomy, since it was the first radio source to be definitely identified with an extragalactic object.

The Andromeda nebula is a galactic system similar to the galaxy in which we are located. It is classified as an *Sb*-type spiral nebula with its axis tilted about 75° from our direction. At a distance of one and one-half million light years, this sister system is a weak radio source and was near the limits of detection of the Manchester radio telescope. At Ohio it was detected with a much smaller, although more efficient, antenna with less resolution in declination but higher resolution in right ascension than the Manchester antenna. The Ohio antenna is 160 ft. long (east–west) and 22 ft. wide (north–south), with an aperture area of 3,520 sq. ft., and operates as a meridian circle instrument. The Manchester antenna, a fixed paraboloid 218 ft. in diameter with an aperture of 37,400 sq. ft., is more than ten times as large.

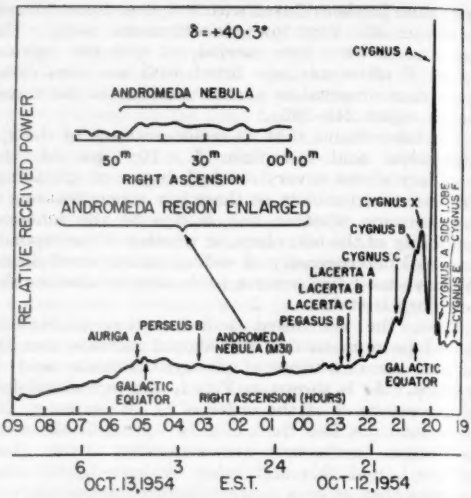

Fig. 1. Single profile taken with the Ohio State University radio telescope on the night of October 12–13, 1954. The largest peak is due to the radio source Cygnus *A*. The Andromeda nebula appears as a small hump near R.A. 00h. 40m. The insert shows the Andromeda region to a larger scale

The Andromeda nebula is situated in a minimum of the cosmic radio background. This is illustrated by Fig. 1, which is a profile of the received power versus time (or right ascension) as obtained with the Ohio State radio telescope on the night of October 12–13, 1954, at a declination of 40·3° N. A large rise near R.A. 20h. 30m. and another smaller one near R.A. 05h. 00m. occur at the galactic equator. The Andromeda nebula is in the valley between them.

The most prominent peak in Fig. 1 is due to the radio source Cygnus *A*. A number of other localized sources[3] are also designated by name. The insert in Fig. 1 is an enlargement of the profile for the Andromeda nebula region showing the record for the night of October 12 to a larger scale.

By averaging six profiles taken at Dec. 41° N. ± 0·7° between October 11 and 17, 1954, it was possible to reduce the random fluctuation of the profile by a factor of approximately 2·5 ($= \sqrt{6}$). This averaged profile (radio brightness) is shown at the top of Fig. 2. This curve indicates that although the radio emission from the nebula is strongest between R.A. 00h. 27m. and 00h. 45m., there is a suggestion of emission out to R.A. 00h. 20m. on the preceding side and to 00h. 51m. on the following side. The slowly varying background gradient has been subtracted from this curve.

For comparison, smoothed contours of optical brightness (isophotes) of the Andromeda nebula are shown at the centre of Fig. 2 as measured by Williams and Hiltner[4]. It is apparent that the strongest part of the radio emission (marked "main body") corresponds in position to the region enclosed by their isophote contour 2. The curve at the bottom of Fig. 2 labelled "photographic brightness" shows how the nebula would appear optically to a device having the same response pattern as our antenna, assuming a uniform optical emission from the region within contour 2. The curve was obtained by moving the

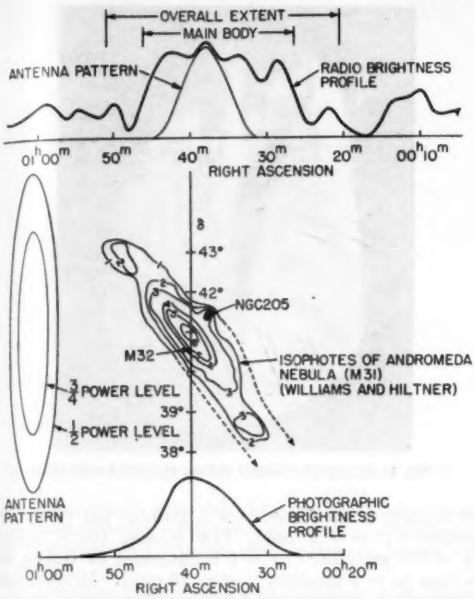

Fig. 2. Radio brightness profile (top curve) across the Andromeda nebula obtained by averaging six records taken with the Ohio State University radio telescope at a declination of approximately 41° N. The ordinate is relative radio brightness. Isophotes for *M*31 as measured by Williams and Hiltner are shown at the centre with a photographic brightness profile (bottom curve) that would be observed with an optical system having the same response pattern as our antenna

antenna pattern (at left of Fig. 2) along the Dec. 41° N. line across the contour of the nebula and computing graphically the received intensity at successive positions. The antenna pattern (for a point source) is 1·3° wide between half-power points in right ascension and 8° wide in declination. The wide beam-width in declination is sufficient to bring all contour 2 within the half-power level when the antenna is at Dec. 41° N.

The optical brightness actually increases toward the nucleus (at R.A. 00h. 40m.), as shown by the higher contour levels, so that the assumption of uniform emission inside contour 2 should increase the extent of the nebula as shown by the normalized photographic brightness curve. In spite of this fact, the photographic brightness curve shows a smaller extent for the nebula than does the radio brightness curve, indicating that the radio emission must be much larger in the outer regions of the nebula than the optical brightness would suggest. Furthermore, the ratio of the radio to photographic brightness for the outer regions must be much higher than the ratio of the radio to photographic intensity for the nebula as a whole.

The amount of significance that can be attached to the small peaks near R.A. 00h. 22m., 29m. and 50m. is not certain. However, the outer ones are sufficiently separated to be due to small areas or bands of emission which can just be resolved by our antenna (1·3° resolution). It is probable that a small increase in resolution would reveal considerably more such fine structure.

Since the nucleus of Andromeda *M*31 is close to R.A. 00h. 40m. at Dec. 41° N., the radio brightness distribution indicates that the nebula is quite asymmetrical. The main body appears to extend 3·5° from the nucleus to the south-preceding side and 1·7° to the north-following side. This extent agrees closely with that of Williams and Hiltner's contour 2. If the peaks on the radio brightness curve at R.A. 00h. 22m. and 50m. are significant, it indicates an approximate overall extent of the nebula of 6° to the south-preceding side and 3° to the north-following side (ratio 2/1), giving an overall diameter of 9°. At a distance of 1·63 million light years (new scale)[5] this means an overall diameter for the nebula of 256,000 light years.

From their isophotes, Williams and Hiltner indicated that the extent of the nebula was at least 6·7°. Their contour 1 was found to extend so far to the south-preceding side that they could not close it on the original negative and it is shown only in part (solid line); the broken line suggests what is presumed to be the general trend of this contour beyond the extent given by Williams and Hiltner. The extent of the Andromeda nebula usually seen on a photograph is about 2°, corresponding to Williams and Hiltner's contour 4 or 5.

Preliminary attempts have been made to construct a model of *M*31 to fit the radio brightness contours of Fig. 2. It is readily possible to obtain an approximate fit by assuming a structure of eccentric emitting rings of increasing size with gaps between them that are especially large for the outermost rings.

In addition to the measurements reported above, profiles across *M*31 were made with the Ohio State University radio telescope later in October at Dec. 44° and 37·5° N. At Dec. 44° N., the main part of the rise in the brightness curve is about 5 min. later than at Dec. 41° N., while at 37·5° it occurs about 5 min. earlier. By the dates of the 44° and 37·5° observations, the transit time of *M*31 was sufficiently early in the evening for interference to be experienced on most nights from frequency-modulation broadcasting stations. Accordingly, only a few good profiles were obtained at these declinations.

The minimum signal that can be detected by our radio telescope corresponds to a randomly polarized incident intensity of about 7×10^{-26} W. m.$^{-2}$ (c./sec.)$^{-1}$ for a single record. The maximum observed intensity of *M*31 (near R.A. 00h. 40m.) is about $2{\cdot}5 \times 10^{-25}$ W. m.$^{-2}$ (c./sec.)$^{-1}$. This includes both polarizations. The total intensity is about four times this value, which makes the total radio intensity of *M*31 at 250 Mc./sec. approximately equal to 10^{-24} W. m.$^{-2}$ (c./sec.)$^{-1}$. Hanbury Brown and Hazard[2] found the same total intensity at 159 Mc./sec. It might be expected that the intensity of *M*31 at 250 Mc./sec. would be approximately 0·63 (= 159/250) as much, instead of the same value. However, this may be explained by integration over a larger source area in the present case.

I am indebted to Geoffrey Keller for helpful discussions and to Donn Van Stoutenburg and Gabriel Skitek for assistance in improving the telescope receiver. The radio telescope project is supported by grants from the Development Fund, the Lovejoy Memorial Fund, and the fund for basic research of the Ohio State University and also by a grant from the National Science Foundation. [Nov. 4.

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LETTERS TO THE EDITORS

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Lung Injury by Impact with a Water Surface

Medical findings during the inquiry into the recent *Comet* disasters have suggested that the possibility of lung damage by impact with a water surface at the terminal velocity of fall (about 160 ft./sec.) should be investigated. It is known from observations on the effects of explosive blast that severe lung damage occurs when the impulse communicated to the chest wall exceeds a certain limit. Penney and Bickley (unpublished report, Min. of Home Security, 1943), after a study of the work of Zuckerman and his collaborators[1] on blast injury, suggested that the lungs of man or any animal would be severely injured by transmission of the shock wave set up if the chest wall were flung inwards with a velocity of 20 m./sec. (66 ft./sec.) acquired in 0·5 m.sec. or less.

Work by E. G. Richardson[2] on the impact of rigid spheres with a water surface may be applied in an attempt to estimate the velocity of impact which might be expected to produce the chest-wall motion specified by Penney and Bickley as being critical. Richardson measured the variation with time of the force of impact, showing that it rises to a peak and becomes relatively small again by the time semi-immersion has been reached. He found his results to be reasonably consistent with the assumption that at any particular instant the sphere carried with it an 'added mass' of water equal to that in a hemisphere erected on the wetted perimeter.

In applying this method of calculation to a non-rigid body, such as the chest of an animal, it will be assumed first that only the motion of that part actually in contact with the water is modified by the impact; this appears reasonable for the relatively small displacements of the chest wall visualized by Penney and Bickley. Assuming further that the chest is a sphere (radius a) and that the radius of the wetted perimeter is c at the instant considered, conservation of momentum between the part of the chest wall immersed and the 'added mass' of water gives approximately:

$$\pi c^2 \mu V = \pi c^2 \mu v + \tfrac{2}{3}\pi c^3 \rho v$$

where V is the incident velocity, v is the velocity of the immersed part of the chest wall of mass μ per unit area, and ρ is the density of the liquid. The inward velocity of the immersed part of the chest wall with respect to the rest of the body must be $V - v\ (= v_c)$, so that the above equation becomes:

$$V/v_c = 1 + 3\mu/2c\rho \qquad (1)$$

If v_c be taken as 66 ft./sec., the corresponding value of V should then be the critical velocity of impact for severe lung damage, according to Penney and Bickley's ideas.

Apart from the approximations made in its deduction, equation (1) can only provide a very rough estimate of the critical velocity of impact for a given animal, because the result of any calculation must depend on the value of c chosen to correspond to a significant area of contact with the water. If the value $a/\sqrt{2}$ be arbitrarily assigned to c (that is, πc^2 is half the total area of cross-section) the critical velocity of impact is 99 ft./sec. for a guinea pig ($\mu = 0{\cdot}70$ gm./cm.^{2}; $a = 3$ cm.), 118 ft./sec. for a mouse ($\mu = 0{\cdot}3$ gm./cm.^{2}; $a = 0{\cdot}8$ cm.) and 94 ft./sec. for a man ($\mu = 3$ gm./cm.^{2}; $a = 15$ cm.). In each case the body is assumed to be of similar shape, offering a similar aspect to the water surface at the moment of impact, and the possibility of protection by thick fur, limbs or clothing has been neglected. The values of μ and a cannot be chosen very precisely, but the critical velocity, as calculated by equation (1), is of the same order for a wide range of size of animal because both μ and a should be roughly proportional to the cube root of body-weight.

Fig. 1. Lungs of a normal guinea pig killed with ether

That the effective 'blow' should be delivered while the body descends through a distance fairly small compared with a seems to be a reasonable assumption on the basis of Richardson's work. Penney and Bickley's 'time' condition, that the stipulated chest-wall velocity be acquired in 0·5 m.sec. or less, should then be easily satisfied in the cases of the guinea pig and the mouse falling at 99 and 118 ft./sec. respectively. For man, however, the position in this respect is more doubtful; at a rate of fall of 94 ft./sec., the distance moved in 0·5 m.sec. is 1·5 cm., or only 10 per cent of the value taken for a.

Some animal experiments were devised for testing the validity of these deductions. A vertical catapult was specially constructed for projecting guinea pigs, belly first, into a large tank of water. Different velocities were used, from 66 to 117 ft./sec. Six animals were anæsthetized with ether, and four others were killed (as judged by respiratory arrest) some ten minutes before the experiment. Controls killed with ether showed no pulmonary pathology (Fig. 1); and lesions of only a trivial nature resulted from projection into cotton wool at about 100 ft./sec.

Grave injury to the lungs, and other viscera, was found in animals projected into water at velocities greater than 104 ft./sec., both anæsthetized and dead specimens giving the same result. The effect was diffuse pulmonary concussion, quite similar to that of blast injury[1,2]. Confluent sub-pleural hæmorrhages were conspicuous (Fig. 2), and in places presented a linear pattern of 'rib markings'. Patches of sub-pleural emphysema and occasional lacerations were also found. Microscopically, there were structural changes throughout the lungs, the lower and middle

Fig. 2. Lungs of a guinea pig projected into water at 107 ft./sec.

lobes being chiefly affected. The predominant lesions were hæmorrhagic consolidation, patchy atelectasis, and traumatic emphysema amounting in places to cavitation.

At slightly lower velocities, similar but more localized lesions occurred, and at less than 75 ft./sec. the lungs were unaffected but for a few small subpleural ecchymoses. The living animals were all killed by the impact, even at the lower velocities, and in no case was there evidence of death by drowning.

These experiments, though few in number, indicate that lung damage can result from impact with a water surface at high incident velocities. The critical velocity for severe injury in the guinea pig would appear to be consistent with the predicted value; but the closeness of the agreement must be regarded as largely fortuitous in view of the approximate nature of the calculations.

We are indebted to Squadron Leader P. Howard, Flight Lieutenant D. I. Fryer and Mr. N. L. Andrews for help and advice with the experimental work. Our thanks are also due to Sir William Penney for allowing us to quote from unpublished work, and to the Director-General of Medical Services, R.A.F., for permission to publish this communication.

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Crystalline-like Patterns in the Nuclei of Cells infected with an Animal Virus

A group of viruses causing very peculiar changes of the infected cells in tissue cultures was recently isolated in our laboratory[1]. The strains were obtained from cases of either mesenteric lymphadenitis or pharyngitis with cervical lymphadenitis. An apparently identical microscopical picture[1] was caused by agents described by Neva and Enders[2] and Hilleman and Werner[3]. So far, all strains exhibiting this pattern of cytopathic activity which have been tested in our laboratory have had complement-fixing antigens in common, although by neutralization tests they could be differentiated into three types[1].

The ultra-structure of cells infected with one of our strains (*L.O.*4574/54, isolated from a mesenteric lymph node) was studied by electron microscopy. HeLa cells[4] were grown in stationary culture tubes on a piece of plastic placed at the bottom. This support for the cells was sliced from a piece of the plastic employed for embedding. Any toxic influence was removed by autoclaving in large amounts of distilled water. The specimens for sectioning were prepared by a modification of methods previously described[5]. For fixation the pieces of plastic with their layer of cells were immersed in a 1 per cent solution of osmic acid (buffered at *p*H 7·2) for 30 min. at a temperature of 0° C. They were then embedded in a methacrylate mixture. The microtome devised by Sjöstrand[6] was used for sectioning.

Figs. 1 and 2 reveal the picture within cells infected 48 hr. earlier with the *L.O.* strain. A tissue culture

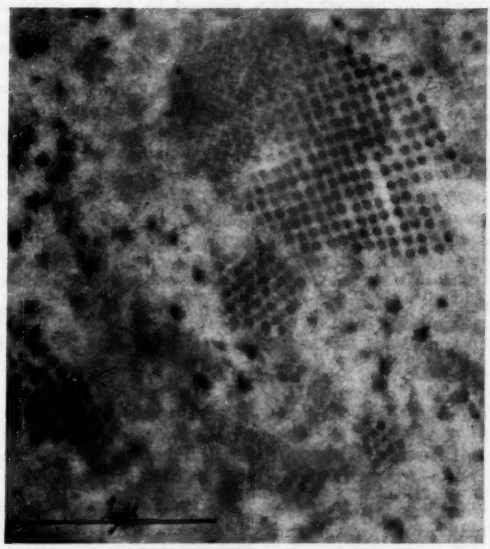

Fig. 1

Fig. 2

fluid filtered through a bacteria-retaining glass filter was used as inoculum in a dose corresponding approximately to $10^{5.5}$ ID_{50} per 10^5 cells. Most nuclei in the sections of infected cultures contained crystalline-like patterns consisting of particles which usually appeared somewhat elongated and measured up to approximately 50 mμ × 30 mμ. These formations were seen more regularly and were often larger 48 hr. after infection than 24 hr. after infection. No similar patterns or particles were seen in sections of non-infected cultures or cultures infected with poliomyelitis virus type 1 (some of these experiments were carried out in co-operation with Dr. Aksel Birch-Andersen and Dr. Fritiof Sjöstrand).

In the preparations so far studied the cytoplasmic structure of cells with intranuclear 'crystals' appeared largely unchanged. This seemed to be in contrast to our findings in cells infected with poliomyelitis virus type 1 (strain *RC*), where cytoplasmic changes were obvious.

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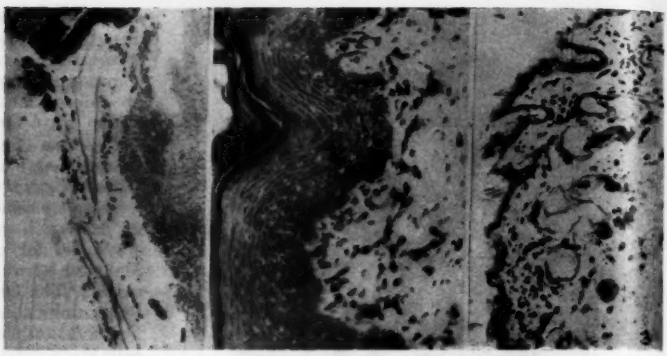

Fig. 1. Salivary gland, top, at left; the cortex of lymph node to the right with connective tissue of excretory canal extremely rich in mast cells. Bouin–Dominici

Fig. 2. Vaginal epithelium with numerous mast cells in the dermis. Bouin–polychrome blue

Fig. 3. Subcutaneous connective tissue from the perineal region with a superabundance of mast cells. Bouin–cresyl violet–picrofuchsine

Effect of Injections of Œstrogen on the Mast Cells of the White Mouse

There is no agreement on the connexion which may exist between mast cells and the function of endocrine glands. It is known that the number of mast cells increases during hypothyroidism[1] and becomes normal in the hypothyroid subjects treated with thyroxin; it is also known that the number of mast cells in the rat and in the white mouse undergoes, under the influence of cortisone, a considerable increase, particularly in the interlobular connective tissue of the thymus, in the lymph nodes and in the bone-marrow[2]. A study of the behaviour of mast cells during other modifications of the endocrine equilibrium should thus be opportune.

Adult white mice, six males and six females, of a stock maintained in this laboratory for several years, were given daily injections of 100γ of dihydrofolliculine benzoate ('benzogyncstryl Roussel'); three animals of each sex were autopsied the day after the third injection and the three others of each sex were killed the day after the sixth injection. Samples of tissues were fixed in Bouin's fluid, sectioned from paraffin and stained with polychrome blue, Mann–Dominici or cresyl violet–picrofuchsine.

Examination of sections revealed a considerable increase in the number of mast cells in all the organs studied: lymph nodes, thymus, visceral connective tissue (salivary glands (Fig. 1), intestine, genital organs (Fig. 2)) and a very great increase in the subcutaneous tissue (Fig. 3). The increase in number of mast cells and the influence of œstrogenic hormone is, as a rule, less in the male mouse than in the female.

This increase in the number of mast cells is different from that described in the general syndrome of adaptation, either after injections of alloxan[3], or after irradiation with X-rays[4], because it is generalized and not limited to hæmopoietic organs. By its generalized effect, this increase in mast cells (labrocytosis) recalls that of hypothyroidism.

It is possible that a thyroid mechanism is implicated in determining the labrocytosis provoked by œstrogens. It is known that folliculin is an antagonist of thyroxin on certain hormone-sensitive organs, as, for example, during the growth of the uterus in the ovariectomized mouse[5], or on the tubular segment of the submaxillary gland of the mouse[6]. This interpretation would explain the observation that labrocytosis is less marked in male mice treated with œstrogen than in females.

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Effect of Growth Hormone on the Large-Particle Content of Rat Liver

In the course of an investigation[1] of rat liver, with respect to hormonal effects on the yield and composition of fractions isolated by differential centrifugation in 0·25 *M* sucrose medium[2], determinations have been made of the particle number in freshly isolated 'large-particle' ('mitochondrial') fractions.

These fractions were obtained from liver homogenates, prepared with a Potter-type homogenizer and centrifuged at a low speed to remove 'debris' containing the nuclei, by further centrifugation for 20 min. in an 'Angle 13' (Measuring and Scientific Equipment, Ltd.) centrifuge at 12,000 *g* (maximum value, at extreme tip of tube). The particles were suspended in 1·8 *M* sucrose solution and counted under dark-ground illumination as described by Allard *et al.*[3]. Under these conditions (in 1·8 *M* sucrose) the particle size-range is decreased (compressed); all visible particles up to and including the mitochondrial size-range were counted.

The study included hypophysectomized albino male rats of about 200 gm. weight, some of which had received daily injections of 0·3 mgm. of pituitary growth hormone (presented by Armour and Co., Chicago) for eight to twelve days. The effect of adrenalectomy was also studied, with albino females of about 250 gm. weight, given saline in place of drinking water. The rats were arranged in groups, such that the experimental rats were compared with control rats (intact or sham-operated) which had been kept on the same food intake, and which were killed on the same day after an overnight fast.

As shown in Table 1, there was a marked increase in 'large-particle number' with hypophysectomized rats given growth hormone. The absence of any significant change with untreated hypophysectomized or adrenalectomized rats suggests that there may be some pituitary hormone, other than adrenocorticotrophin, which has an influence converse to that of growth hormone on particle number. As reported elsewhere[1], hypophysectomy or adrenalectomy slightly diminishes the weight yield of the 'large-particle' fraction, and on administration of growth hormone to hypophysectomized rats the weight yield shows an increase which is, however, considerably smaller than the increase in number now reported.

Table 1. PARTICLE COUNTS ON 'LARGE-GRANULE' FRACTIONS ISOLATED FROM RAT LIVER

Hormonal status*	Particle number†, as per cent of that for control rats studied simultaneously (values calc. as No./100 gm. body-weight)
Hypophysectomized	123 ± 17·5 ($n = 5$)
Hypophysectomized + growth hormone	371 ± 25·7 ($n = 6$; $P \ll 0{\cdot}1\%$)
Adrenalectomized	116 ± 39·0 ($n = 5$)

* Operated animals were killed two to three weeks after operation.
† Mean ± stand. error; n denotes number of observations, and P the probability that difference from controls could be due to chance.

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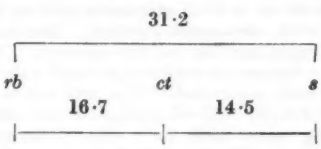
The Hypothesis of Chromosomal Interference

IT has been known for a long time that both chromatid and chromosomal interference produce similar effects on recombinations recovered in classical genetical (Mendelian) analysis in which single chromatids are sampled. Although deviations from a unitary coincidence are probably due either to chromatid or chromosomal interference, the classical method does not permit one to determine whether one or the other, or both, processes are effective in producing the deviations. It is strange, therefore, that chromosomal interference has been the accepted explanation of non-unitary coincidence since the very beginning of modern genetical analysis. The utility of either hypothesis in the analysis of single-chromatid experiments may be demonstrated by considering the following map:



The expected frequency of double-recombinations would be $16{\cdot}7 \times 14{\cdot}5 \times 10^{-4}$, or 2·4 per cent, whereas the actual frequency is only 0·9 per cent. The accepted conclusion has been that one cross-over actually interferes with the occurrence of another, the 'strength' of this interference being indicated by the coincidence value (in this case, 2·67). The hypothesis of chromatid interference is, however, equally applicable if one supposes that adjacent cross-overs form four-strand double exchanges at a frequency equal to or greater than 72 per cent.

Tetrad analysis provides an opportunity of discriminating between these two types of interference. The only positive data on this subject may be summarized as follows.

(1) Negative chromosomal interference exists in *Neurospora*[1], that is, the presence of one cross-over 'facilitates' rather than inhibits the occurrence of another.

(2) A mapping function which assumes a Poisson distribution of the number of cross-overs has produced additive distances in the otherwise non-additive recombination data in yeast, indicating that cross-overs occur independently of one another in these regions (C. C. Lindegren and E. E. Shult, to be published).

It is clear from these findings that the existence of chromosomal interference has been neither demonstrated nor proved.

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Crystalline Trypsin Inhibitors from the Indian Field Bean and the Double Bean

While studying the digestibilities of some Indian pulses, Gaitonde and Sohonie[1], from this laboratory, reported the detection of a trypsin inhibitor in field bean, *Dolichos lablab*. Since then, Sohonie and collaborators[2] have surveyed various Indian foodstuffs for the inhibitory factor and studied their properties in general. The field bean was found by them to be a fairly rich source of this principle and, as a continuation of their work, a simple method by which the trypsin inhibitor from field beans is obtained in a crystalline form is described here. Kunitz[3], Bowman[4], Tauber and co-workers[5] have isolated similar crystalline preparations from different plant materials such as soybean, navy bean and lima bean respectively.

1,000 gm. of defatted field bean meal was extracted with 5,000 ml. of 0·25 *M* sulphuric acid at 25–28° C. for 1 hr. with occasional stirring. The suspension was centrifuged and the residue rejected. The supernatant was saturated with magnesium sulphate and the precipitate separated. This was taken up with 500 ml. of 2·5 per cent trichloracetic acid and heated in a boiling water-bath for 5 min. The suspension obtained was suddenly chilled in an ice-bath and filtered. The filtrate was saturated for the second time with magnesium sulphate and centrifuged. The residue was dissolved in 100 ml. water and dialysed in a 'Cellophane' bag in a running stream of water. After about 20 hr., the contents of the bag, free from magnesium and sulphate ions, were centrifuged and the supernatant was precipitated by four volumes of cold acetone. The acetone precipitate was separated by centrifugation and dissolved in a minimum quantity of water and lyophilized. The yield was about 1·5 gm.

This material has a light straw colour, is very easily soluble in water and shows a strong inhibitory action on trypsin. When to the aqueous solution 1 *M* sulphuric acid was added drop by drop until a faint turbidity appeared, and this was allowed to stand at room temperature, long needle-shaped crystals, visible under the microscope, were formed within a short time (Fig. 1). This inhibitor gave a strong biuret reaction and was found to contain 13·6 per cent nitrogen.

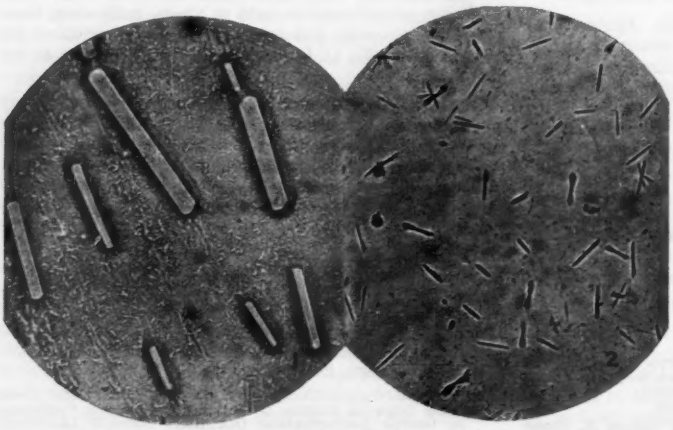
With the view of evaluating the potency of the preparation, the effect of different concentrations of it on trypsin was studied. Digestion tubes with various amounts of the field bean inhibitor and a constant quantity of the enzyme at 7·6 *p*H were kept for preliminary incubation for 10 min. at 37° C. The skimmed milk substrate was then added and the tubes were further incubated for 10 min. The extent of inhibition was determined by Anson's[6] colorimetric method. Proper controls were run simultaneously. The results are presented in Table 1.

Table 1. Effect of Field Bean Inhibitor on Trypsin (Merck)

Trypsin in each tube	5 mgm.
Skimmed milk in each tube	150 mgm.
Volume of the reaction mixture	5 ml.
Concentration of the inhibitor (mgm.)	**Inhibition (per cent)**
5	100
2·5	100
1·25	97
0·5	82

It will be seen that the field bean preparation exerts a strong inhibitory action on trypsin, as it almost completely inhibits four times its weight of the enzyme. Similar results obtained by Laskowski, Mars and Laskowski[7], Fraenkel-Conrat and others[8] and Viswanatha and Liener[9] using crystalline trypsin with trypsin inhibitors from other sources show that the proportion of the inhibitor to trypsin for complete inhibition of the latter varies from 0·78 in the case of ovomucoid inhibitor to 2·65 in the case of Kazal pancreatic inhibitor. Whether the higher activity obtained for the field bean inhibitor as compared to that of the crystalline trypsin inhibitors mentioned is due to the fact that non-crystalline trypsin (Merck) was used in the present investigation is now being studied.

Subjecting double bean (*Faba vulgaris*) flour to a similar treatment, a trypsin inhibitor was prepared by using ammonium sulphate instead of the magnesium salt. An alternative method consisting of the extraction of the double bean meal directly with 2·5 per cent trichloracetic acid, heating the suspension and removal of the inhibitor in the filtrate, subsequent dialysis, acetone, precipitation of the inhibitor from the supernatant followed by lyophilization, also gave a similar material. The yield was 0·25 gm./100 gm. of the bean flour. Fine needle-shaped crystals clustered together were obtained on treating this lyophilized powder in a similar manner with 1 *M* sulphuric acid (Fig. 2). The double bean preparation is chalk-white, extremely soluble in water and shows a strong inhibitory action on trypsin; one part was found to inhibit completely five parts of Merck trypsin powder. The double bean inhibitor was remarkably heat-stable. As much as 95 per cent of the inhibitory activity was retained even after autoclaving at 15 lb. for 30 min. The preparation contained 12 per cent nitrogen. When tested qualitatively, it gave strong biuret and tryptophan reactions and a positive Molisch test.



Crystalline trypsin inhibitors from (1) field bean; (2) double bean. × 240

Further studies on the composition, physico-chemical properties, etc., are in progress and will be published elsewhere. We are indebted to the Council of Scientific and Industrial Research for finan-

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An Effect of Certain Proteins and Amines on Prostatic Acid Phosphatase

HIGH dilutions of seminal fluid in physiological saline often show markedly lower acid phosphatase activity than similar dilutions of the same specimen in serum or serum derivatives[1]. This difference is especially marked in specimens which have been stored for some days or weeks in the refrigerator. Similar differences may be found between the acid phosphatase activity of saline extracts of human prostate diluted with saline and those diluted with serum derivatives.

It was found that by the addition of gelatine it is possible to maintain phosphatase activity in saline-diluted seminal fluid as effectively as in the presence of serum. Fig. 1 shows the curve of acid phosphatase activity of highly diluted seminal fluid in samples containing different concentrations of gelatine. Results are expressed as a percentage of the activity obtained in the presence of 50 mgm. gelatine/100 ml. The specimens which were used for these experiments showed in complete absence of gelatine less than 20 per cent, and usually less than 10 per cent, activity. At a concentration of approximately 30 μgm. gelatine/100 ml. the activity was about half that obtained in the presence of 50 mgm. gelatine/100 ml.

The concentration of any substance required to give half the activity shown by a sample containing 50 mgm. gelatine/100 ml. in any given preparation of prostatic phosphatase was taken as a constant of activity, A, for the comparison of different substances. A expressed in μgm./100 ml. was 30 for gelatine, 50 for blood albumin, 21 for salmine sulphate and 20 for clupein sulphate. A similar effect was found with a number of amino-compounds; but far greater concentrations were required for comparable activity. The values of A for some of these substances, expressed in millimoles/litre, were as follows: ethylamine, 143; ethylene diamine, 7; trimethylene diamine, 11; tetramethylene diamine, 6·7; pentamethylene diamine, 4·5; hexamethylene diamine, 0·19; spermidine ($NH_2.(CH_2)_3.NH.(CH_2)_4.NH_2$), 0·15; decamethylene diamine, 0·08; spermine ($NH_2.(CH_2)_3.NH.(CH_2)_4.NH.(CH_2)_3.NH_2$), 0·03; and 'Synthalin A' ($NH_2.(NH:)C.NH.(CH_2)10.NH.C(:NH)NH_2$), 0·015.

The effect is seen to increase with the chain-length between terminal amino-groups. It is not decreased by the formation of benzyl or dinitrophenyl derivatives, but is completely destroyed by acetylation. Amides and α-amino-acid groupings are inactive: malonamide is completely inactive up to a concentration of $M/10$, whereas trimethylene diamine shows half activity (A) at $M/90$; histidine and tryptophan are both inactive (at $M/10$ and $M/100$, respectively), but histamine and tryptamine each have a value of A of about $M/200$. Arginine has a slight effect, with a value of A about $M/17$; but this can be attributed entirely to the guanidino group, as the value of A for guanidine is about $M/20$. Ornithine also shows a slight effect, but less than that of ethylamine; none was found for lysine, asparagine, citrulline, serine or glycine, up to a concentration of $M/10$.

The action of gelatine is not significantly reduced by peptic digestion, but is very markedly reduced by digestion with trypsin or papain (the digestive enzyme was inactivated by boiling carried out before the test), and is completely destroyed by hydrolysis with 8 N hydrochloric acid. This supports the hypothesis that the effect of proteins and peptides is related to the amino-groups of basic side-chains, linked through the peptide chain to produce an effect similar to that of the long-chain polyamines.

The effect described appears to be due to a protective action of these substances which prevents inactivation of the enzyme on extreme dilution, since addition of gelatine after the start of incubation fails

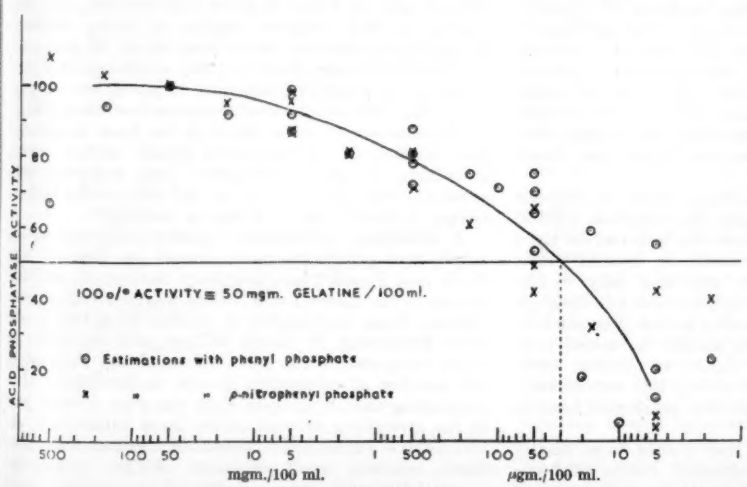

Fig. 1

to restore acid phosphatase activity. This destruction or denaturation of the enzyme would appear to be an immediate outcome of the final dilution in the substrate mixture, due perhaps to surface denaturation by the glass tubes, as suggested by London and Hudson[2]. Curves for enzyme activity are linear, both in the presence of protective substances as well as in their absence when activity is at the minimum.

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Detection of Vascular Tissues available for Water Transport in the Hop by Colourless Derivatives of Basic Dyes

In the course of a study of the host–parasite relations in *Verticillium* wilt of the hop, it has been observed that infection of the vascular system by the pathogen is frequently accompanied by the development of numerous tyloses, and that a considerable proportion of the vascular elements in a diseased plant may thus be rendered useless for the passage of water.

The extent of such obstruction in the vascular cylinder as a whole is not readily determined by examination of transverse sections, for the absence of tyloses in certain vessels in the plane of the section does not preclude the possibility that they may be present in those same vessels at levels above or below that of the section. A more satisfactory method is to allow the plant to take up an aqueous solution of a dye which will stain permanently any vessels through which it passes. Sections prepared afterwards will then give a clear indication of the parts of the wood available for water transport.

A number of stains at a concentration of 0·1 per cent in water were introduced into hop plants by petiole injection following the methods of Roach[1], and also by severing the stem at soil-level and inserting the cut end in a tube of the solution. It was found that acidic dyes, for example acid fuchsin, light green and eosin, travelled freely in the plant but diffused from the vascular elements into neighbouring tissues and in subsequent processing were more or less completely removed from the vessel walls.

Basic dyes such as malachite green, methylene blue, safranin, crystal violet and basic fuchsin stained lignified tissues deeply but were far less mobile than the acidic types. Basic fuchsin or crystal violet applied by petiole injection travelled only a few millimetres from the point of application and induced wilting. Thus none of the stains tested was suitable for the purpose, although it should be noted that in some other species, for example tomato, basic fuchsin was found to travel slowly but extensively, and little wilting occurred until the plant had become fairly generally injected.

Satisfactory results with hop plants were finally achieved by the use of colourless forms of basic fuchsin and crystal violet derived by treatment of the dyes with sodium metabisulphite. 10 per cent aqueous sodium metabisulphite was added slowly and with vigorous shaking to 100 ml. of 0·1 per cent solution of basic fuchsin or crystal violet in water (B.D.H. Standard Stains) until the dye was almost completely decolorized. This required approximately 5·0 ml. of metabisulphite for basic fuchsin and 10·0 ml. for crystal violet. A faint residual colour appeared to have no undesirable effect, and a considerable volume of metabisulphite solution was required to remove it entirely.

Application of such solutions through the base of the stem or by petiole injection led to intense staining of the vascular elements in the immediate vicinity within 1–3 min., and the stain was transported throughout the vascular system of a healthy plant at a rate comparable with that of the mobile acidic dyes.

Sections cut from the stained material were counter-stained with 1 per cent light green in 95 per cent ethanol and dehydrated for preparation of permanent mounts without loss of stain from the vessel walls.

Short segments of the stem were treated with hot 15 per cent nitric acid for 5–15 sec. to remove epidermal and cortical tissues, dehydrated in ethanol and cleared in clove oil for preservation as permanent whole-mounts.

The basic fuchsin derivative appears to be relatively non-toxic, and it is possible that it might be used in growth studies for 'marking' vascular tissues *in situ* in growing plants. The method may also be useful in anatomical studies of, for example, the structure of the nodal regions of shoots.

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Role of Sulphydryl Groups in the Long-range Elasticity of Wool

Fibres of wool and hair may be stretched nearly 100 per cent in water at room temperature, and they return to their original lengths on being released. If a fibre is stretched more than about 30 per cent, or if stretched very slowly to any extension and then released, subsequent stretching requires less energy, indicating that an irreversible change has taken place[1]. In explanation of these effects it has been postulated that hydrolysis of disulphide bonds occurs during stretching to give sulphydryl and sulphenic-acid groups; but direct evidence for the production of either of these in wool or hair is lacking[2,3].

A sensitive colorimetric method for estimating sulphydryl groups in wool, based on that of Van Scott and Flesch[4], has now been developed, and full details of the method and results will be reported elsewhere. Tests on samples of merino wool before and after stretching to about 60 per cent in water at room temperature have not revealed any increase in the number of sulphydryl groups on stretching, thus suggesting that hydrolysis does not play a large part in the stretching of wool under these conditions. An alternative explanation, based on the fact that wool fibres contain small amounts of free sulphydryl groups[5] and that they are difficult to stretch in acid solution[3], is as follows:

If, during the stretching of a wool fibre, a sulphydryl group comes into contact with a disulphide bond, reduction may occur with the formation of a new sulphydryl group and a new disulphide bond:

$$R^1\text{—}CH_2\text{—}SH + R^2\text{—}CH_2\text{—}SS\text{—}CH_2\text{—}R^3 = R^2\text{—}CH_2\text{—}SH + R^1\text{—}CH_2\text{—}SS\text{—}CH_2\text{—}R^3$$

or $= R^3\text{—}CH_2\text{—}SH + R^1\text{—}CH_2\text{—}SS\text{—}CH_2\text{—}R^2$,

where R is part of a polypeptide chain. Since the fibre is under tension, the new disulphide bonds will tend to be such that they do not oppose stretching, so that in a stretched fibre some of the disulphide bonds will have been rearranged, with the elimination of those that opposed stretching. Unless these are reformed during contraction, subsequent extensions of the fibre after release will be easier, although the number of disulphide bonds and sulphydryl groups will be unchanged. Sulphydryl–disulphide interchanges in solution have been reported for simple peptides[6], ovalbumin[7] and bovine plasma albumin[8].

According to the above mechanism, wool fibres with no free sulphydryl groups should be more difficult to stretch than usual. Fig. 1 shows part of the elongation of three groups of merino fibres—purified root ends from one staple of wool *E6N*—under a load of 6×10^5 gm. per cm.^{2} cross-section at 25° measured by the direct loading method[9]. Fibres of group *A* were treated for four days with a 0·05 *M* solution of N-ethylmaleimide in *p*H 7·4 phosphate buffer to block sulphydryl groups; those of group *B* were treated for the same time with the buffer solution only; while those of group *C* were untreated. Fibres of group *A* and group *B* were stretched in water and those of group *C* in 0·1 *N* hydrochloric acid. There is little difference during the initial rapid extension to about 37 per cent; but beyond this, the fibres of group *A*, which had been treated with N-ethylmaleimide, stretched at a much slower rate than those of group *B*, which had not been treated with this reagent, and, in fact, were almost as slow as the fibres stretched in acid (group *C*). Similar results were obtained if iodoacetamide or mercuric chloride were used in place of N-ethylmaleimide. With the possible exception of mercuric chloride, these reagents should not be able to form new cross-links in the fibres, so the slower rates of stretching are presumably due to inhibition of sulphydryl–disulphide interactions.

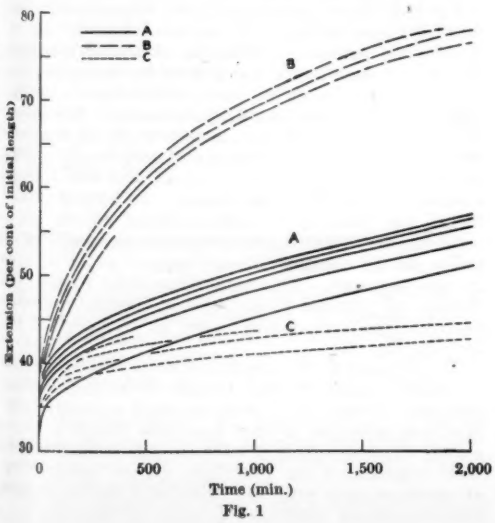

Fig. 1

It is possible that this process has a wider application in wool chemistry. For example, it appears to play some part in supercontraction by means of phenol. The supercontraction of merino fibres (from sample *E9N*) after boiling for 10 min. in 50 per cent aqueous phenol[10] was found to be 11·3 per cent (average of values for eight fibres, coefficient of variation 24·2 per cent, probable error 1·0) for fibres that had been pretreated for two days with 0·1 *M* iodoacetamide at *p*H 8; as compared with 25·5 per cent (seven fibres, coefficient of variation 11·3 per cent, probable error 1·2) for untreated fibres from the same staple.

I am indebted to Dr. P. C. Carman for his advice and criticism, to the South African Wool Board for sponsoring this work, and to the South African Council for Scientific and Industrial Research for permission to publish this report.

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Molecular-sieving Properties of Starch

Molecular-sieving by porous adsorbents and carriers generally used in column chromatography is a potential analytical method[1]. Comparatively little, however, is known about their working-ranges in molecular-weight separation, that is, the pore diameters of the different substances. In connexion with zone-electrophoretic examination of cheese extracts on a starch column, a very distinct molecular-sieve effect was incidentally observed. In order to investigate to what extent this effect could be used for determining the molecular-weight distribution among the peptides of the sample, a solution of the cheese in citrate buffer *p*H 6·7 (21 gm. citric acid monohydrate + 290 c.c. *N* sodium hydroxide to a volume of 1 litre) and a mixture of amino-acids dissolved in the same buffer were 'chromatographed'. The dimensions of the starch column were 2 cm. × 120 cm. 275 fractions of 1 ml. were collected from about 75 mgm. of applied substance at a rate of 4 ml./hr. The elution curves obtained showed that the substance was separated into two peaks, one of which had the same position as the amino-acid peak (Fig. 1), whether it was obtained from the synthetic mixture or prepared from the cheese[2]. Chromatographic and electrophoretic examination of certain fractions of these peaks confirmed the identity between the latter and the amino-acids.

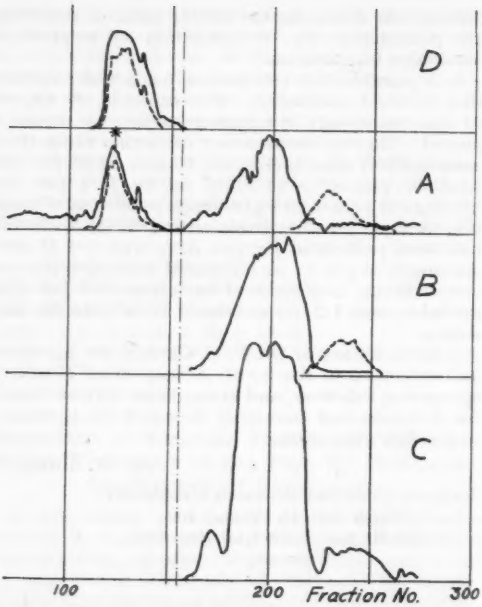

Fig. 1. Molecular-sieving on starch column of cheese extracts dissolved in citrate buffer pH 6·7. Solid lines represent ninhydrin reaction, broken lines phosphorus content. Peaks to the left of the vertical broken line (fraction 155) represent material which cannot enter the starch grains. Peaks to the right of the line represent material which can freely enter the water present in the starch grains.
A, Total cheese extract. The asterisk * shows the fraction containing the peptide of relatively low molecular weight (see text). *B*, Amino-acids of the same extract obtained by ethanol precipitation of peptides. *C*, Mixture of amino-acids in the same proportions as those in which they are to be found in casein. *D*, High-molecular peptides obtained from cheese extract by dialysis

Further experiments with cheese extract dialysed in 'Cellophane' for 36 hr. against tap water showed that the first peak corresponded approximately to the material which did not diffuse (molecular weight greater than 13,000[3]). In the first peak, however, there could be shown chromatographically, at the point marked * in curve *A*, a peptide forming a distinct round spot on the chromatogram. This indicates that the molecular weight of this peptide cannot be very high[4]. From this we conclude that starch acts as a molecular sieve with a separation range between the molecular weights of the amino-acids (75–200) and those of the peptides which can still be chromatographed (maximum about 500). There are obviously possibilities for analytical work in this field, and it also seems that it may be possible to isolate amino-acids preparatively from mixtures of peptides using a starch column.

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Nov. 11.

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Ion-Exchange Separations on Chemically Modified Cellulose

In a study of methods for flame-proofing cotton fabrics, Dr. J. D. Guthrie *et al.*, of the U.S. Department of Agriculture, have prepared a number of chemically modified cellulose fabrics and have described[1] their ion-exchange properties. The same workers have modified the *p*H of sample solutions obtained during the preparation of protein from oil seed[2] by addition of phosphorylated and aminated cotton fabrics. While suitable for this type of operation, the modified cellulose in fabric form is not a convenient material on which to carry out chromatographic separations, and the possibility of converting the fabric to pulp and then to paper has been explored. Using aminated and phosphorylated cotton fabrics as starting materials, experimental sheets of paper have been prepared by W. and R. Balston, Ltd., which have since been examined at the Chemical Research Laboratory. The preparation of sheets of paper with suitable chromatographic properties is still in the experimental stage; but the separation of a number of inorganic mixtures has been achieved with the materials so far available.

Separations of cationic mixtures were carried out on strips of phosphorylated paper prepared from cotton fabric which had been treated with urea phosphate. This material had a phosphorus content of 3·85 per cent and a capacity of 2·04 milliequiv. per gm., which is in approximate agreement with the findings of other workers[3] that the phosphate group is singly bound to the cellulose, leaving two hydrogen atoms available for exchange. Separations were carried out on strips of paper 1 cm. in width and 20 cm. long. A solution of mixed metal salts in dilute acid was placed near one end of a paper strip which was allowed to dry in the atmosphere. The strength of the test solution was adjusted so that the quantity of metals placed on the paper did not exceed the capacity of the area of paper covered by the dried sample spot. Chromatographic development was achieved by the upward diffusion of various aqueous salt and mineral acid solutions. The position of the separated metals was then found by spraying the strip with suitable reagents.

An excellent separation of iron, copper and nickel was obtained using 2 *N* sodium chloride as the developing solvent. When a solution containing 50 μgm. of each metal was placed on the strip, very sharp narrow bands of each metal were obtained (Fig. 1*a*) having the following R_F values: ferric iron, 0·0; copper, 0·3; and nickel, 0·5. With the same developing solution, aluminium and beryllium remained with the iron, while cobalt and lead had R_F values of 0·4 and 0·5 respectively. In further experiments the quantity of metals placed on the paper strip was increased sufficiently to be in excess of the ion-exchange capacity of the area of paper covered by the test spot. This resulted in wider bands; but it was still possible to separate 0·5 mgm. quantities each of iron, copper and nickel on strips of 20 cm. length (Fig. 1*b*).

The separation of anionic mixtures was attempted on sheets of paper prepared from cotton fabrics which had been treated with 2-amino-ethyl sulphuric acid. Modified cellulose of this type was found to have strong water-repellent properties, and more difficulty was experienced in preparing paper suitable for chromatographic purposes than was the case with phosphorylated cellulose. In spite of the very poor

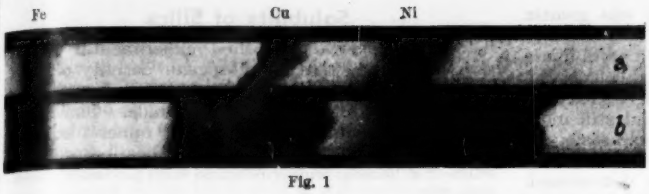

Fig. 1

and uneven wetting properties of the sheets of paper available, it was possible to obtain a partial separation of gold, platinum, palladium and rhodium as their chloro acids. A solution of 2 *N* hydrochloric acid was used as developing solvent, and R_F values of 0·2 for gold, 0·3 for platinum, 0·4 for palladium and 0·6 for rhodium were obtained; but the bands were diffuse and slightly overlapping. Further work is in progress aiming at producing more suitable sheets of paper.

Separation of cation mixtures was also achieved on columns of phosphorylated paper pulp. In these experiments, columns (6 cm. × 1 cm.) were prepared from a mixture of phosphorylated pulp blended with untreated cellulose pulp. These were washed with dilute hydrochloric acid to convert the pulp to the hydrogen form and then with a mixture of 2*N* sodium chloride and *N*/10 sodium carbonate to convert to the sodium form. A mixture containing 5 mgm. each of ferric iron, copper and nickel was adsorbed on to the top of each column, which was then eluted with an aqueous salt or acid solutions. With *N*/2 hydrochloric acid, copper and nickel were eluted rapidly with 25 ml. of acid, leaving the iron at the top of the column. Using molar calcium chloride, nickel was eluted in the first 25 ml. of solution, followed by copper in the next 50 ml. of solution, while iron was found firmly retained at the top of the column. To remove the iron it was found necessary to use a complexing agent such as acetone containing hydrochloric acid, which rapidly eluted the iron and left the column in the hydrogen form ready for re-use.

We thank the Director of the Chemical Research Laboratory, Teddington, for permission to publish this communication.

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Nov. 22.

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A Chromatographic Separation of *Meta*- and *Para*-Cresols

The separation of isomers has always been a major problem in analytical chemistry. In the case of *meta*- and *para*-cresols, this difficulty is a very real one, for in the absence of spectroscopic apparatus there is no available method for determining both these components.

In this laboratory the application of partition chromatography for this purpose has been investigated, and the work has led to the complete separation of the two isomers.

In the method developed, the column is 1 cm. in internal diameter and has a packed length of 45 cm. The packing is 13 gm. of 'Celite 535' to which 5 ml. of the stationary phase has been added, the latter being a 0·5 *M* phosphate buffer of *p*H 11·5. Commercial *cyclo*hexane is the mobile phase, which is forced through the column by pressure from a nitrogen cylinder at 0·8 ml. per min.

The cresols are placed on the column in a solution which is *M*/100 with respect to each component. The progress of the chromatogram is followed by a spot test which is given by 2 : chloro : 4 : nitrobenzene diazonium naphthalene : 2 : sulphonate. A drop of the eluate is mixed with a drop of an aqueous solution of the reagent; to this is added a drop of 2 per cent sodium hydroxide, and, if any cresol is present, a red colour develops. This spot test will readily detect 5 parts per million of cresols.

The eluate is collected in 2-ml. fractions and analysed colorimetrically using the reagent mentioned above. The results of this work are shown in Table 1. *Ortho*-cresol is included to show that all the isomers are separated, although the separation of *ortho*-cresol from the other two isomers is not particularly difficult.

Table 1

	Position of peak	Total fraction containing the isomer	Weight of isomer taken (mgm.)
Ortho-cresol	36·5	35–40	0·1
Para-cresol	59·0	56–69	0·3
Meta-cresol	77·0	72–87	0·1

The platage of the column has been calculated using the second method of James and Martin[1]. The volume which would have contained the two mid-standard deviations is obtained by plotting the cumulative fraction percentages on logarithmic probability paper. This gave a theoretical plate-height of 0·45 mm.

The work has been only of a qualitative nature so far; but it is hoped to use this separation as the basis for a quantitative method of estimation of the three isomeric cresols.

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Potassium Permanganate in the Kjeldahl Method for the Determination of Nitrogen in Organic Substances

An investigation into the mode of occurrence of nitrogen in coals necessitated devising a suitable method for its determination. The ordinary macro-Kjeldahl method was much improved in speed and reliability by using a mixed selenium–mercury catalyst with the usual potassium sulphate; but even in this case some doubt always existed as to when the conversion of all the combined nitrogen of the substances into ammonia was complete, and whether there might be loss of ammonia during the digestion, which was

indeed observed when the temperature was greater than 370° C.

Quite recently, a rapid and reliable semi-micro method that uses an oxidizing agent—potassium permanganate—instead of the usual catalysts (oxygen carriers) has been described by me[1], and still more recently this has been applied to the micro-scale. In the semi-micro method 1–2 mgm., and in the micro-method 0·2–1 mgm., of nitrogen are determined, digestion being conducted with 10 ml. and 2 ml. of sulphuric acid respectively, in 8 in. × 1 in. glass boiling-tubes each heated by a controllable micro-burner. A preliminary digestion of about five minutes is given, and after slight cooling, potassium permanganate is added in successive small amounts with shaking until the digest becomes char-free. After boiling for one minute and cooling somewhat, sufficient permanganate is added to produce a dirty sage-green coloration. Digestion for a further minute completes the conversion. The ammonia is determined by steam distillation from the alkalinated digest, the condenser tube being of clear silica instead of glass to avoid the pick-up of alkali, and the receiver contains 1–2 ml. of a three-quarters saturated solution of boric acid. Distillation is complete in six minutes, and the condensate is titrated with centinormal hydrochloric acid using methyl red–methylene blue indicator.

Digestion occupies about twelve minutes, cooling about five, and the distillation and allied operations take about ten minutes, so that an individual determination can be performed in about 30 min., though it is easily possible unaided to do about thirty-six determinations per working day.

Using permanganate, an investigation has shown that about 90 per cent of the nitrogen of coals has been converted at the char-free stage, the remaining 10 per cent being converted by the final permanganate addition and the short after-boiling. With resistant non-charring substances, all the conversion occurs during the last period. It has been found, contrary to expectation using such a powerful oxidant as potassium permanganate, that no loss of nitrogen (or ammonia) occurs at any stage of the digestion, not even when, subsequent to completion, the acid digest is boiled for two hours with excess permanganate. The temperature, however, should not rise above 330°.

On the semi-micro scale coals, cereals, feeding stuffs, leather and various alkaloids of low nitrogen content have been satisfactorily tested, while the same success, using micro-amounts, has been achieved with pyridine carboxylic acids, tryptophan, and all the alkaloids so far examined.

Both methods have been favourably reported upon by independent workers and can, it is believed, fairly be claimed as the most nearly perfect Kjeldahl method so far devised. A considerable degree of uncertainty has existed in values obtained by earlier methods where the rate of heating, type and amount of catalyst, temperature and duration of digestion may all have adverse effects on the values obtained.

The micro-method, with details of the investigations leading to its evolution, will shortly be published.

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Solubility of Silica

In 1932, Kettle published experimental results which suggested that the fibrogenic activity of silica in silicosis is due to silicic acid formed when the inhaled dust dissolves in tissue fluids. Since that time, the dissolution of silica and mineral silicates in water and physiological fluids has been widely studied in laboratories concerned with pneumoconiosis research.

When powdered silica is added to water, the concentration of dissolved silicic acid increases rapidly at first but afterwards much more slowly. "All sizes of quartz particles behaved as if a soluble fraction of silica was being leached from their surfaces, leaving a relatively insoluble residue, or core, which seems to be resistant to the dissolving action of water. The amount of leachable silica which can be dissolved from the particles is greater with the samples of small size quartz than with those of larger size"[1].

The phase of rapid solution has been variously attributed to trace impurities in the silica[2], to rapid solution from sharp edges and corners[3] and to a thick disorganized layer[4] analogous to the Beilby layer on metals. The layer was estimated to be 200–1500 A. thick. Heavens[5] was unable to find evidence for a thick amorphous layer on a quartz crystal by electron diffraction methods.

We have evidence that the anomalous solubility characteristics of silica are due to an incomplete monolayer of adsorbed silicic acid on the silica surface. The evidence for this layer is as follows:

(1) When silica is extracted with alkali, the curve corresponding to the slow reaction shows a linear concentration–time relationship. Extrapolation of the curve until it cuts the axis at zero time indicates the amount of silica which dissolves rapidly. As a monolayer, this amount (0·13 mgm./gm. on a powder of surface area 1 m.²/gm.) would extend over 0·16 of the surface.

(2) Powder which has been treated in this way with alkali will rapidly adsorb from a silicic acid solution an amount of silicic acid equivalent to that rapidly removed by alkali.

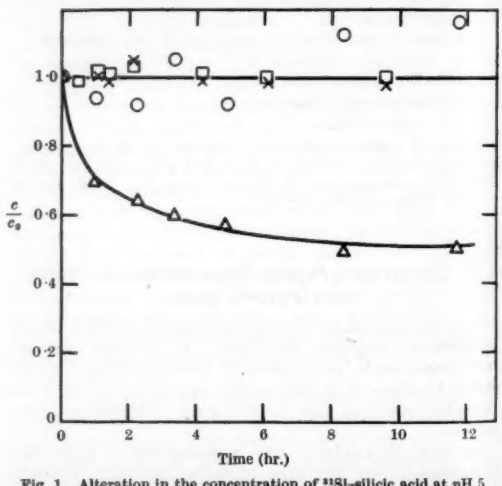

Fig. 1. Alteration in the concentration of ^{31}Si-silicic acid at *p*H 5 (△) and *p*H 9 (□) and total silicic acid at *p*H 5 (○) and *p*H 9 (×) on adding a silica powder to a silicic acid solution. The change in the concentration of the solute is denoted as the ratio of the concentration (c) after a measured time to the initial concentration (c_0)

(3) Silica in the layer, but not silica in the lattice, will exchange in alkaline but not in acid solutions with silicate solution labelled with silicon-31. When a silica powder is added to a 'saturated' ^{31}Si–silicic acid solution at *p*H 5, neither the total concentration of the silicic acid nor the concentration of the labelled silicic acid in the solution is changed (see Fig. 1). If the experiment is carried out at *p*H 9, the total concentration of the silicic acid is still unaltered, but the concentration of the labelled silicic acid is reduced, indicating that exchange has occurred between the dissolved silicic acid and the silicic acid that is adsorbed on the silica surface.

If it is assumed that the extent of the surface-layer of adsorbed silicic acid does not vary, the weight of adsorbed silicic acid in a unit weight of powder can be calculated when the surface area is known. On considering the data from several laboratories, we find that the amount of silicic acid we predict to be on the surface is in most cases identical with that which was observed to dissolve rapidly according to the published figures.

It is evident that the widely varying 'solubility' values previously reported for quartz represent mainly the mass of the adsorbed layer. The reported dependence of the solubility on the mass of solid extracted and on the particle size can now be explained.

A detailed account of this work will appear in the *Journal of the Chemical Society*. We are indebted to the British Steel Castings Research Association for financial assistance.

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Rheological Properties of Coal during Carbonization

The work on viscosity changes in coal during carbonization first reported in *Nature*[1] has been extended to include other rheological properties of coal, in particular its instantaneous and retarded elasticities.

Coal was subjected to sudden application and removal of stress during constant-temperature carbonization in a modified Gieseler apparatus (as described in ref. 1) and the strain-retardation and stress-relaxation phenomena were observed. It was found that the mechanical properties of the coal can be represented by a spring-dashpot model. The simplest model consistent with the observed phenomena is a Maxwell model in se ies with a Voigt–Kelvin model as shown in Fig. 1, where two springs of stiffness G_1 and G_2 represent the elastic behaviour of the material, while two dashpots of resistance η_1 and η_2 represent the flow viscosity and the internal viscosity respectively. The relaxation-time (that is, the time in which an applied stress decays by a factor $1/e$) is $\tau_1 = \eta_1/G_1$, while the retardation-time (the time in which a strain reaches $1/e$ of its final value on stress change) is $\tau_2 = \eta_2/G_2$.

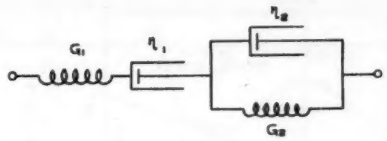

Fig. 1

The modified Gieseler apparatus was used as follows. The sample is raised at 3 deg. C. per min. to a temperature within the plastic zone, and is then kept at the temperature reached. A stress is applied and then removed when conditions are steady. The rate of change of strain before removal gives η_1, and the strain observations after removal, which are made at 5-sec. intervals for 1 min., give the values of G_1, G_2 and η_2 when extrapolated to zero and infinite time. (Separate experiments showed that the extrapolation to infinite time according to an exponential law is justified.) Thus, in a period of about two minutes, one set of values of the four parameters is obtained. These values are assumed to remain sensibly unchanged during this short period. Their change in the course of the carbonization is shown in Table 1. The values refer to a typical good South Wales coking blend (coal rank code number 301, 24·6 per cent dry ash-free volatile matter), carbonizing at 438° C. The figures refer to a single carbonization, but are typical.

Table 1

Parameter	Minimum value	Rises according to*
η_1	7×10^4 poises	$6 \times 10^4 \exp 0{\cdot}14t$
G_1	30 to 40×10^8 dynes/cm.^{2}	$40 \times 10^8 \exp 0{\cdot}07\ (t-10)$†
$\tau_1 (= \eta_1/G_1)$	about 0·002 sec.‡	$0{\cdot}003 \exp 0{\cdot}07t$
η_2	130×10^8 poises	$130 \times 10^8 \exp 0{\cdot}07t$
G_2	7×10^8 dynes/cm.^{2}	$7 \times 10^8 \exp 0{\cdot}07\ (t-5)$†
$\tau_2 (= \eta_2/G_2)$	about 15 sec.	constant at 25–30 sec.

* t in minutes. Zero time is taken at the minimum viscosity value.
† The exponential rise begins later as the elasticity minima are less sharply defined than those of the viscosities.
‡ The low values of τ_1 were confirmed qualitatively by direct stress relaxation measurements at constant strain.

In order to test the adequacy of the model, a briquette of a Barnsley Seam coal (coal rank code number 601, 36·7 per cent dry ash-free volatile matter) was compressed during carbonization in a specially designed apparatus. Allowing for the continuous contraction of the briquette (on account of loss of volatile matter) which was superimposed on the strain, the stress–strain–time relationship was found to correspond exactly to that expected from the model (see Fig. 2).

By the help of the model it was possible to make allowance for the slight viscous flow in a briquette at carbonizing temperatures and to treat the briquette as a body having purely elastic properties. The value of Young's modulus at these higher temperatures could then be measured (using the special apparatus mentioned above). The results show that Young's modulus increases steadily in rising-temperature carbonization, with a dip in the region of about 550°–600° C. The modulus rises to about 5×10^9 dynes/cm.^{2}, which is the highest value the apparatus will distinguish from absolute rigidity. The activation energy for this process can be calculated from the temperature coefficient of the rate of rise of elasticity with time at constant temperature. A value of 50 ± 8 k.cal. per mole was found.

It is of interest to compare this latter value with that of $52{\cdot}7 \pm 2{\cdot}8$ k.cal. per mole reported earlier[1]

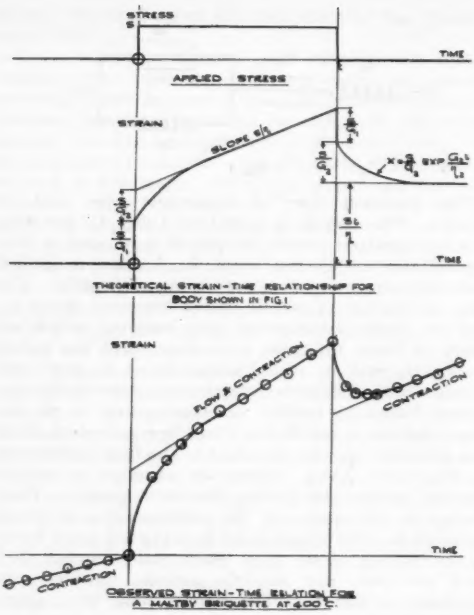

Fig. 2

for the activation energy for the decomposition reaction within the plastic zone, determined from the rate of rise of viscosity with time at constant temperature. It is possible that increase both of viscosity and elasticity are aspects of the same fundamental process leading from a relatively mobile fluid to an elastic solid, and that the chemical changes taking place are of constant nature throughout.

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Conductivity induced in Unplasticized 'Perspex' by X-rays

The conductivity induced in unplasticized 'Perspex' (polymethylmethacrylate) by X-rays differs markedly from that induced in ordinary plasticized 'Perspex'. First, the time-constant of recovery after irradiation is very long (several hours) for the unplasticized material, whereas for ordinary 'Perspex' it is much shorter[1]. Secondly, the equilibrium induced current i_x is related to the dose-rate R by the general formula :

$$i_x \propto R^{\Delta} \qquad (1)$$

where $\Delta = 0{\cdot}55 \pm 0{\cdot}05$ for unplasticized 'Perspex', but Δ is nearly unity for plasticized 'Perspex'. These properties place unplasticized 'Perspex' in the same class of behaviour as polyethylene[1,2], polytetrafluorothene[3], and polystyrene[4,5].

The range of dose-rates was 2–64 r./min., and the range of temperature 20°–80° C. for plasticized, and 20°–100° C. for unplasticized 'Perspex'. The measurements were made, as previously described[1], using a d.c. amplifier to measure the current in a specimen placed in a chamber which could be evacuated. The X-rays were generated at 220 kVp., with a half-value layer of 1·7 mm. of copper.

Dependence on temperature. Fig. 1 shows the graphs of log (conductivity) of unplasticized 'Perspex' plotted against the reciprocal of absolute temperature. The resulting straight lines are of slope proportional to the activation energy W according to the general formula :

$$\sigma = \sigma_0 \exp(-W/kT) \qquad (2)$$

In the case of static conductivity (no incident radiation ; Fig. 1*a*) $W = 1{\cdot}6$ eV., rather greater than for some of the other materials we have measured (polythene 1·5 eV., polytetrafluoroethylene 1·1 eV., polystyrene 1·2 eV.). This is consistent with the low value of static conductivity itself observed in unplasticized 'Perspex'.

For the equilibrium induced conductivity under X-irradiation (Fig. 1*b*) at $R = 7$ r./min., the slope corresponds to $W_x = 0{\cdot}5$ eV. This value of W_x is substantially the same as in the other materials mentioned, making it appear that the process of induced conductivity is fundamentally the same in all of them. The actual values of induced conductivity for unplasticized 'Perspex' are comparatively low, and similar to the values for plasticized 'Perspex'.

The variations of induced current with temperature shown in Fig. 1 are consistent with the model of an exponential distribution of traps in depth, based on the theory of photoconducting insulators[6] that we have used previously. Between 20° and 80° C., the induced current is observed to increase by a factor of 20, whereas theory predicts a factor of 5 when $\Delta = 0{\cdot}55$. The agreement is not unreasonable for this type of experiment.

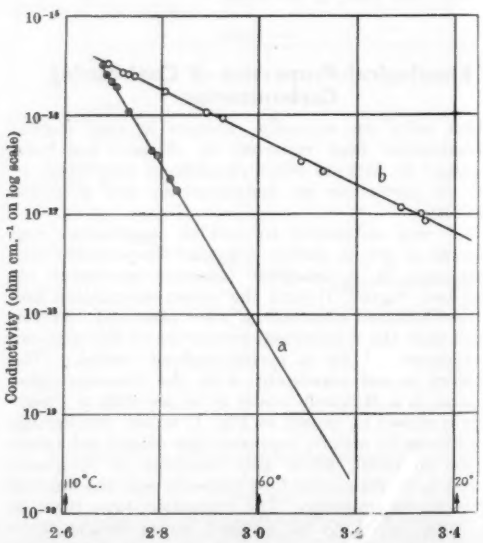

Fig. 1

Table 1

Material	Δ at 80° C.	Time to fall to 10 per cent at 80° C.	Time to fall to 1 per cent at 80° C.	Induced conductivity at 20° C. for 7 r./min. (ohm-cm.)$^{-1}$
Polyethylene	0·8±0·05	3 min.	30 min.	10^{-18}
Polytetrafluoroethylene	0·62±0·05	6 hr.	35 hr.	10^{-16}
Polystyrene	0·60±0·05	3 hr.	20 hr.	10^{-17}
Unplasticized 'Perspex'	0·55±0·05	10 hr.	50 hr.	10^{-17}

Table 1 lists the materials which we consider should be grouped together because they display a markedly exponential distribution of traps in depth, as exemplified by values of Δ which depart considerably from unity.

It will be seen that the hyperbolic decay given by

$$\frac{1}{i_t} = \frac{1}{ix} + At \qquad (3)$$

(where i_t is the current remaining at time t, and A is a constant characteristic of the material) is true over the range 10–1 per cent decay for polythene but not for the other materials. A full discussion of decay curve analysis will be given elsewhere; it is sufficient here to say that equation (3) applies between $t \approx 5$ min. and $t \approx 5$ hr., the decay becoming exponential instead of hyperbolic at longer times.

It should be mentioned that the low conductivities measured here for unplasticized 'Perspex' will seldom be obtained in practice owing to the effect of absorbed moisture.

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A Semi-annual Periodicity in the Beginnings of Recurrent Magnetic Storm Series

Records of geomagnetic disturbances during the seven sunspot cycles from 1884 to 1954 reveal a strong tendency for the initial disturbance of a 27-day recurrent series to occur near January or July. Final disturbances of such series show this tendency only weakly.

This result was obtained from graphs of 3-day moving averages of the magnetic character figure C through the years of declining sunspot activity, 1884–91, 1895–1901, 1907–13, 1917–23, 1929–34, 1938–44 and 1948–54, inclusive—a total of 48 years. All identifiable series of three or more recurrences were considered. A few series, and many individual disturbances, were of less than 'storm' intensity. The method of analysis was to locate any apparent case of 27-day recurrence of magnetic disturbances,

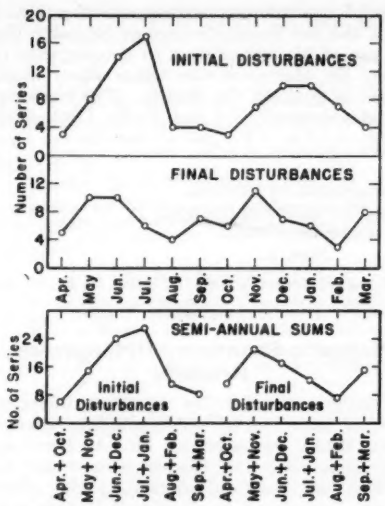

Fig. 1. Distributions of the initial and final dates of 27-day recurrent series of geomagnetic disturbances

and to trace the series forward and backward in time as far as additional members could be identified. This procedure probably admitted a few random disturbances by time coincidence; but it dealt symmetrically with the initial and final members of each series.

When the dates of the initial disturbances of all the series so identified were tabulated by the calendar months in which they occurred (Fig. 1), a plot of the resulting sums showed an unmistakable tendency toward a semi-annual periodicity with maxima about January and July. Sixty-six of the ninety-one series began in the months May, June, July, and November, December, January, leaving only twenty-five during the other six months. If the number of initial disturbances occurring in the same calendar month during a particular sunspot cycle is treated as a single datum, the probability that the observed difference between these two groups is the result of random fluctuations is about 10^{-4}. The difference between the summer and winter maxima is not significant. A similar analysis of the dates of the final disturbances of recurrent series suggested a weak semi-annual periodicity in phase with that of the initial dates, with the inconclusive probability 0·04.

The indication that most recurrent series begin on dates approximately midway between the equinoxes suggests a relation to the well-known maximum in recurrent storm activity near the equinoctial dates. Yet the wide range in the number of recurrences in a series (from 3 to more than 50, with a median of 18), together with the absence of a definite periodicity in the final dates of series, discourages any simple interpretation. The effect may be related to the fact that the earth crosses the plane of the solar equator on June 6 and December 7.

A tentative indication of a 23-year periodicity in recurrent storm activity, reported earlier[1], was not substantiated by this more extensive analysis.

I wish to thank Dr. Walter O. Roberts, director of the High Altitude Observatory of Harvard University and the University of Colorado where the research was done; Dr. Jean-Claude Pecker for suggesting

the use of the moving average plots; Mr. Fred Ward, of the Air Force Cambridge Research Center, for the use of his compilation of geomagnetic data; and Mrs. Eli Heitz, of the Observatory staff, for assistance in plotting the results. The research was supported principally by the Radio Corporation of America.

J. H. Rush

Department of Physics,
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Lubbock, Texas.
Nov. 1.

[1] Rush, J. H., and Trotter, Dorothy E., *Astron. J.*, **59**, 191 (1954).

Magnetic Structure of Manganese Arsenide

We have examined by neutron diffraction a number of samples of polycrystalline manganese arsenide, MnAs, prepared by Mr. A. Bentham by heating manganese and arsenic in a sealed quartz tube, with the view of confirming the antiferromagnetism postulated by Guillaud[1] in this material between the two transformation temperatures of about 40° and 130° C. No new reflexions due to antiferromagnetism have been observed, nor have we found any intensity changes within this region greater than the possible experimental errors. It seems clear that any antiferromagnetism must be very weakly developed: unfortunately, the precision of the experiment is much reduced by the fact that the important reflexions (0002) and (10$\bar{1}$1) are almost coincident in the powder diffraction pattern.

In the ferromagnetic region, from room temperature down to 80° K. which is the lowest temperature we have yet employed, the results suggest that the magnetic moments of the manganese atoms are not aligned along the *c*-axis, as was at first supposed, but, to a first approximation, are perpendicular to *c*.

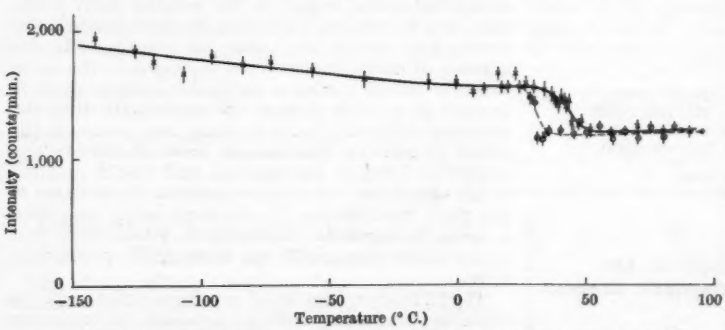

Fig. 1. Neutron diffraction by manganese arsenide: variation of intensity of 10$\bar{1}$0 reflexion with temperature. ———, Heating; – – –, cooling

We are at present engaged in the preparation of single crystals of the material, by fusion of manganese and arsenic in an atmosphere of argon at pressures of the order of 1,000 lb./sq. in., with the hope of making a thorough investigation of the magnetic moment orientation from the much more intense and well-defined single-crystal neutron reflexions. Fig. 1, which shows some results already obtained by partial isolation of a grain in a coarse-grained specimen, illustrates the power of the method. The (10$\bar{1}$0) reflexion from this grain had a peak count of 1,600 neutrons per min., compared with 200 neutrons per min. from a large powder sample: this count was sufficiently large for the temperature-intensity curve to be plotted quite accurately as the substance passed through the lower transformation temperature, due allowance being made for the change in unit-cell dimensions[2] which was observed in the experiments. The temperature hysteresis in the transformation, as indicated by the rise and fall of magnetic scattering with decrease and increase of temperature respectively, is clearly shown in Fig. 1.

It is hoped to publish a more detailed account of this work at a later date.

G. E. Bacon
Atomic Energy Research Establishment, Harwell, Berks.

R. Street
Department of Physics, University, Sheffield.

Nov. 11.

[1] Guillaud, C., *J. Phys.*, **12**, 223 (1951).
[2] Willis, B. T. M., and Rooksby, H. P., *Proc. Phys. Soc.*, **B**, **67**, 290 (1954).

An Amplifier based on the Hall Effect

The very high electron mobility shown by the semiconducting compound indium–antimony, InSb [1], when sufficiently pure, means that the power available from the Hall effect is sufficiently high to make possible a number of new applications[2]. We have now been able to achieve power amplification by using the effect in the following way.

The signal to be amplified, d.c. or a.c., is fed to a suitably matched coil wound on a laminated magnetic core, in which it induces a corresponding flux. The core is closed except for a narrow gap into which is inserted a thin rectangular slice of single-crystal indium–antimony. Direct current is made to flow through the slice parallel to its long axis, by means of soldered copper leads, the current being provided by a local battery. The Hall effect due to the combined field and current gives rise to an e.m.f. orthogonal to both. This is picked up by a pair of transverse leads and connected to a matched load. The current in the load is then a replica of the original signal.

In a first experimental arrangement a power gain of five has been measured; but there is no theoretical reason why much higher values should not be attained with a single stage. Cascading of stages presents no difficulty. An upper frequency-limit is set by core losses.

We are indebted to the Admiralty for permission to publish this communication.

I. M. Ross
N. A. C. Thompson

Services Electronics Research Laboratory,
Baldock, Herts.
Jan. 14.

[1] Madelung, O., and Weiss, H., *Z. Naturforsch.*, **9(a)**, 527 (1954).
[2] Baker, E. W., and Cunnell, F. A., *Research*, **7**, 114 (1954).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 21

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 3 p.m.—Symposium on "Transducers".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Materials for Valves".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PESTICIDES GROUP and the AGRICULTURE GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Meeting on "The Crop Protection Products Approval Scheme: Part 3—"The Analysis of Fungicides". Mr. J. R. Gray: "Sulphur Products"; Dr. F. R. Cropper: "Organo Mercurials".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Creep". (Second of three Cantor Lectures on "The Mechanical Properties of Metals".)

INSTITUTE OF METAL FINISHING (at Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. R. J. Heritage: "Electrodeposition of Aluminium".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.15 p.m.—Prof. W. A. Fowler (California Institute of Technology): "Recent Developments in American Science".* (From a series of lectures on "The United States of America".)

Monday, March 21—Wednesday, March 23

INSTITUTION OF CHEMICAL ENGINEERS (at Church House, Westminster, London, S.W.1)—O.E.E.C. Conference organized by the Institution on "The Functions and Education of the Chemical Engineer in Europe".

Tuesday, March 22

PHYSICAL SOCIETY (in the Lecture Hall of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 5 p.m.—Prof. E. C. Stoner, F.R.S.: "Magnetism in Retrospect and Prospect".

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (at the Royal College of Science, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. A. R. Ubbelohde, F.R.S.: "Thermodynamics in the World To-day". (Inaugural Lecture.)

ROYAL METEOROLOGICAL SOCIETY (at Trinity Grammar School for Boys, Wood Green, London, N.22), at 5.30 p.m.—Mr. F. H. Ludlam: "Clouds". (Meeting open to Sixth-form Scholars.)

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "High-Voltage Equipment in Colleges".

Wednesday, March 23

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. Harold F. Lock: "Industrial Psychology—a Practitioner's Point of View". (Chairman's Address.)

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. A. C. B. Lovell: "Radio Astronomy".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. A. Thom: "A Statistical Examination of the Megalithic Sites in Britain".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mrs. Hilda Lewis: "Inadequate Parents and Psychological Disorders in their Children".*

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. Christie, Mr. H. Leyburn and Mr. J. F. Bird: "Proving the Performance of Circuit-Breakers, with particular reference to those of Large Breaking Capacity"; Mr. J. Christie, Mr. H. Leyburn and Mr. R. W. Fenn: "A New Testing Station for High-Power Circuit-Breakers".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the FOOD GROUP—NUTRITION PANEL and the OILS AND FATS GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. S. J. Folley, F.R.S.: "Some Aspects of Fat Metabolism with Special Reference to the Biosynthesis of Milk Fat".

Thursday, March 24

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion on "Hybrid Vigour", opened by Prof. K. Mather, F.R.S.

BONE AND TOOTH SOCIETY (at the Institute of Orthopædics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Repair Processes in Bones and Teeth".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. T. M. Cherry: "A New Quasi-automorphic Function".

MINERALOGICAL SOCIETY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—The Right Hon. Lord Hailey: "Post-war Changes in Africa".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. F. B. Shaw and Mr. J. W. McHugo: "Development and Use of the Calorimeter Building at the Fuel Research Station, Greenwich".*

ROYAL AERONAUTICAL SOCIETY (at the Institute of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1), at 6 p.m.—Mr. K. V. Diprose: "Analogue Computing Applied to Aeronautical Problems".

Thursday, March 24—Saturday, March 26

UNIVERSITY COLLEGE LONDON (joint meeting with the PHYSICAL SOCIETY, in the Department of Physics, Gower Street, London, W.C.1)—Conference on "Recent Developments in Cloud Chamber and Associated Techniques".

Friday, March 25

ASSOCIATION OF CLINICAL BIOCHEMISTS, SOUTHERN REGION (at the North Middlesex Hospital, Silver Street, Edmonton, London, N.18), at 3 p.m.—Business Meeting, followed by Scientific Papers.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Discussion of papers received during the session.

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir Geoffrey Taylor, F.R.S.: "Diffusion and Mass Transport in Tubes". (38th Guthrie Lecture.)

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. R. C. Worster and Dr. D. F. Denny: "Hydraulic Transport of Solids".

BRITISH ASSOCIATION OF CHEMISTS (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8 p.m.—Dr. P. Haas: "Some Aspects of the Chemistry of Seaweeds".* (Hinchley Address.)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. George Boex: "A Century of Aluminium".

Saturday, March 26

EAST SUSSEX COUNTY COUNCIL (at the County Grammar School for Girls, Lewes, Sussex), at 10.30 a.m.—Conference on "The Teaching of Science in Grammar Schools".

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (at the Institute of Education, Malet Street, London, W.C.1), at 2.30 p.m.—Prof. Fred T. Tyler (U.S.A.): "Unity and Inter-relatedness in Human Development".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at the University, Reading), at 2.30 p.m.—Symposium on "Chemical Aspects of Semiconductors".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANTS (2) (preferably with an honours degree in bacteriology or equivalent qualification) IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (March 26).

LECTURER IN ASTRONOMY, and LECTURERS (2) IN RADIO-ASTRONOMY—The Registrar, The University, Manchester 13 (March 26).

ASSISTANT CHEMIST (with a degree in chemistry of a British university and/or Associate of the Royal Institute of Chemistry) for work which will involve both chemical and bacteriological analyses of water under the supervision of the chief chemist, work outside the laboratory and in the field—The Engineer and General Manager, Water Board Offices, Corporation Road, Middlesbrough (March 31).

LECTURER (with a university degree and Corporate member of the Institute of Chemical Engineers, and preferably with some previous teaching and industrial experience) IN CHEMICAL ENGINEERING, at Birkenhead Technical College—Director of Education, Birkenhead Education Committee, 63 Hamilton Square, Birkenhead (April 2).

SCIENTIFIC OFFICERS (3) (with a first- or second-class honours degree in a scientific subject, and with an interest in administration and organization of scientific research) in the Department of Scientific and Industrial Research, London Headquarters, for scientific administration—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.67/5A (April 2).

ASSISTANT LECTURER or LECTURER (with special interests in infrared spectroscopy) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (April 6).

READER and/or SENIOR LECTURER IN MECHANICAL ENGINEERING; LECTURER or ASSISTANT LECTURER IN MECHANICAL ENGINEERING; SENIOR LECTURER, LECTURER or ASSISTANT LECTURER IN CIVIL ENGINEERING OR SURVEYING, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 7).

SENIOR LABORATORY TECHNICIAN (with special training in embryology and histology) IN THE DEPARTMENT OF ANATOMY, University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (April 7).

ASSISTANT LECTURERS IN APPLIED MATHEMATICS; CHEMISTRY (with special reference to inorganic chemistry); ORGANIC CHEMISTRY; GEOLOGY (with special interests in palæontology); and PSYCHOLOGY—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (April 9).

HEAD OF CHEMISTRY/PHYSIOLOGY GROUP (Senior Principal Research Officer or Chief Research Officer grade) IN THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (April 9).

LECTURER (preferably with research experience in polymer science) IN CHEMISTRY—The Registrar, The University, Manchester 13 (April 9).

SENIOR BIOCHEMIST (Principal Research Officer or Senior Principal Research Officer grade) IN THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra, to reorganize and develop a research programme in fields of relevance to basic problems of plant growth—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (April 9).

LECTURER OR ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, The University, Leeds 2 (April 11).

CHAIR OF CHEMISTRY at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (April 12).

SIR JESSE BOOT CHAIR OF ORGANIC CHEMISTRY—The Registrar, The University, Nottingham (April 13).

I.C.I. RESEARCH FELLOWS IN BACTERIOLOGY, BIOCHEMISTRY, BIOMOLECULAR STRUCTURE, BOTANY (Plant Biochemistry and Biophysics), CHEMICAL ENGINEERING, CHEMISTRY, CHEMISTRY OF LEATHER MANUFACTURE, CHEMOTHERAPY, COLOUR CHEMISTRY AND DYEING, ENGINEERING (Civil, Electrical or Mechanical), FUEL AND REFRACTORIES, GEOLOGY (including Geochemistry), METALLURGY, MINING (Selective Flotation and Geophysical Surveying), PHARMACOLOGY, PHYSICS, PHYSIOLOGY OF TEXTILE INDUSTRIES (Protein Chemistry and Wool Textile Engineering)—The Registrar, The University, Leeds 2 (April 15).

CHAIR OF ELECTRICAL ENGINEERING—The Registrar, The University, Edgbaston, Birmingham 15 (April 16).

PHYSICIST OR MECHANICAL ENGINEER (with a good honours degree in physics or mechanical engineering, or equivalent professional qualifications, and some experience in research and practice in the instrument field) at the Central Research Establishment, National Coal Board, Isleworth, Middlesex, to carry out research concerned with the design and development of mechanical and electro-mechanical instruments required for mining research, including certain aspects of health and safety—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/944 (April 20).

SHELL RESEARCH STUDENT IN CHEMICAL ENGINEERING—Shell Professor of Chemical Engineering, Department of Chemical Engineering, Tennis Court Road, Cambridge (April 23).

LECTURER (with experience in electron microscopy) IN BIOPHYSICS—The Registrar, The University, Manchester 13 (April 25).

ASSISTANT LECTURER IN AGRICULTURAL BOTANY—The Registrar, The University, Reading (April 30).

CHAIR OF BOTANY, and CHAIR OF GEOLOGY—The Joint Clerk to the University Court, The University, St. Andrews (April 30).

CHAIR OF MECHANICAL ENGINEERING—The Registrar, The University, Sheffield 10 (April 30).

CHAIR OF PHYSICAL METALLURGY—The Registrar, University College, Singleton Park, Swansea (April 30).

CHAIR OF VETERINARY PATHOLOGY—The Registrar, The University, Liverpool (April 30).

SENIOR LECTURER IN PHYSIOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, April 30).

CHAIR OF ANTHROPOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 1).

LIBRARIAN (with a university degree in science and the qualifying certificate of the Library Association of Australia, or its equivalent, and with experience in a technical library), to take charge of a technical library serving the Division of Entomology, Division of Plant Industry and the Land Research and Regional Survey Section of the C.S.I.R.O., Canberra—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 121/122 (May 7).

ESSO STUDENT IN CHEMICAL ENGINEERING—The Registrar, Imperial College of Science and Technology, London, S.W.7 (May 13).

ESSO STUDENTS (2) IN CHEMICAL ENGINEERING—The Registrar, University College, Gower Street, London, W.C.1 (May 14).

LECTURER IN THE PHILOSOPHY OF SCIENCE—Secretary of Faculties, University Registry, Oxford (June 1).

ESSO STUDENTS (2) IN CHEMICAL ENGINEERING—The Registrar, The University, Edgbaston, Birmingham 15 (June 11).

SENIOR LECTURER (with a higher degree (for example, Ph.D.) or equivalent qualification, and preferably with lecturing experience) IN PHYSICS, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 15).

CHEMIST OR CHEMICAL ENGINEER (with an honours degree in chemistry or chemical engineering or equivalent qualifications) in the Operation Branch of the Industrial Group, U.K. Atomic Energy Authority, Risley, to be responsible for defining the technical requirements of the raw materials uranium and thorium, and for ensuring the suitability of ores and concentrates for use in the existing and proposed extraction processes within the Industrial Group—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, Warrington, quoting 842.

CHEMIST (with a first- or good second-class honours degree or equivalent qualification and considerable experience in general analytical work and in the rapid investigation of day-to-day problems) in the Central Laboratory, Chiswick—The Staff Officer (F/EV.528), London Transport, 55 Broadway, London, S.W.1.

LABORATORY TECHNICIAN (preferably with experience in instrument making) to develop a laboratory workshop and to assist in routine research and class preparation—The Secretary, University of Nottingham School of Agriculture, Sutton Bonington, Loughborough.

LECTURER IN PHYSICS—Clerk to the Governing Body, Northern Polytechnic, Holloway, London, N.7.

PHYSICIST OR PHYSICAL METALLURGIST, Principal Scientific Officer grade (with a first- or second-class honours degree in physics or metallurgy, and some years appropriate research experience), to lead a section carrying out basic and applied research into radioactive metals and alloys—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 542/WGE/2.

PHYSICIST (with a good honours degree in physics or physical chemistry) in the Divisional Laboratory, Birmingham, for work which includes airborne dust measurement, microscopy settlement of fine solids in water and calibration of instruments—The Divisional Establishment Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs.

PHYSICISTS, Grades 1 and 2 (with an honours degree in physics or equivalent) in the Research and Development Branch, U.K. Atomic Energy Authority, Risley, for liaison with the research and development laboratories and investigation of research requirements in the general fields of physics, reactor technology and physical metallurgy—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 837.

PHYSICISTS OR PHYSICAL CHEMISTS (with a good honours degree and preferably some research experience), for work which will involve both fundamental and applied research on textile fibres and related materials—The Appointments Officer, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

RESEARCH ASSISTANTS (2) IN PHYSICAL CHEMISTRY—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Privy Council. Medical Research Council Special Report Series. No. 285: Fibrosis of the Liver in West African Children. By J. H. Walters and J. C. Waterlow. Pp. 71+43 plates. (London: H.M. Stationery Office, 1954.) 8*s.* 6*d.* net. [3112

National Institute of Agricultural Botany. Farmers' Leaflet No. 3: Varieties of Potatoes. Pp. 6. Farmers' Leaflet No. 5 (Revised July 1954): Strains of Sugar Beet. Pp. 4. Farmers' Leaflet No. 6 (November, 1954): Strains of Fodder Beet and Mangel. Pp. 6. (Cambridge: National Institute of Agricultural Botany, 1954.) [3112

Linen Industry Research Association. Report of the Council, 1954. Pp. 20. (Belfast: Linen Industry Research Association, 1954.) [3112

Association of Universities of the British Commonwealth. United Kingdom Postgraduate Awards (Fellowships, Scholarships, Grants, etc.), 1954–55. List of Awards tenable at Universities in the United Kingdom; Short List of Awards tenable Overseas. Pp. 117. (London: Association of Universities of the British Commonwealth, 1954.) [3112

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953. North Eastern Division. By C. W. Scott. Pp. ii+30. 2*s.* net. West Midland and Southern Division. By J. E. Henshaw. Pp. ii+24. 1*s.* 6*d.* net. Northern Division. By W. Brown. Pp. ii+30. 1*s.* 6*d.* net. (London: H.M. Stationery Office, 1954.) [3112

Commonwealth Institute of Entomology. Report of the Sixth Commonwealth Entomological Conference, 7th–16th July, 1954. Pp. iv+344. (London: Commonwealth Institute of Entomology, 1954.) 30*s.* [3112

Other Countries

Bulletin of the American Museum of Natural History. Vol. 105, Article 2: Desmatochoerinae, a New Subfamily of Oreodonts. By Prof. C. Bertrand Schultz and Charles H. Falkenbach. (Contribution to the revision of the Oreodonts (Merycoidodontidae), Nr. 6. Publication of the Frick Laboratory, Department of Mammals; The American Museum of Natural History, in cooperation with the University of Nebraska State Museum.) Pp. 143–256. Vol. 105, Article 3: Lower Leonardian Brachiopoda of the Sierra Diablo. By Francis Greenough Stehli. Pp. 257–358+plates 17–27. 1.75 dollars. Title Page and Index to Vol. 103, 1953–54. Pp. viii+465–469. Title Page and Index to Vol. 104, 1954. Pp. viii+461–469. (New York: American Museum of Natural History, 1954.) [2112

Unesco. Middle East Science Cooperation Office. List of Scientific Papers published in the Middle East (Afghanistan, Cyprus, Egypt, Iran, Iraq, Israel, Lebanon, Pakistan, Sudan, Syria and Turkey). No. 8 (December 1952): Pp. i+85. No. 9 (December 1953): Pp. i+74. No. 10 (July 1954): Pp. i+74. (Cairo: Unesco Science Cooperation Office, 1952–1954.) [2112

Carnegie Institution of Washington. Publication 603: Contributions to Embryology—Vol. 35, Nos. 231–241. Pp. iv+237+54 plates. (Washington, D.C.: Carnegie Institution of Washington, 1954.) 12 dollars, paper; 13 dollars, cloth. [2312

New Zealand Forest Service. Forest Research Institute. Forest Research Notes, Vol. 1, No. 11: Annual Report of the Forest Research Institute for the year ended 31 March 1954. Pp. i+30. Vol. 1, No. 12: Combined Taper and Volume Tables for *Pseudotsuga taxifolia* Rotorua; *Pinus nigra* var. *calabrica*, Rotorua; *Pinus radiata*, Rotorua. By G. Duff. Pp. i+39. (Wellington: Government Printer, 1954.) [3112

Scientific Reports of the Indian Agricultural Research Institute for the year ended 30th June 1952. Pp. i+108. (Delhi: Manager of Publications, 1954.) 4 rupees, 2 annas; 6*s.* 6*d.* [3112

Veröffentlichungen des Fraunhofer Instituts Freiburg I.B. Sonnen-Zirkular für die Monate Juli, August, September 1954. Pp. 36. (Freiburg im Breisgau: Fraunhofer Institut, 1954.) [3112

Report of the King Institute of Preventive Medicine, Guindy, for the period from 1st April 1951 to 31st March 1952, and Report of the Government Analyst, Madras. By Dr. Y. S. Narayana Rao and Sri S. Narayana Ayyar. Pp. 119+2. (Madras: Government Press, 1954.) [3112